The Journal of Parasitology

Volume 34 DECEMBER, 1948 Number 6

OBSERVATIONS ON EXPERIMENTAL Q FEVER[1]

CORNELIUS B. PHILIP

Principal Medical Entomologist, United States Public Health Service

This paper reports data on miscellaneous experiments concerned with transmission of the Q fever organism, *Coxiella burneti* (Philip, 1948), mostly based on pre-war studies. The test guinea pigs, unless otherwise stated, were kept isolated in cages or cans and their daily temperatures taken with individual sterile thermometers. All recovered or afebrile animals were challenged after varying periods with controlled infectious material of "Nine Mile" strain, which was also used in all these tests. Because of the characteristic lesion induced in guinea pigs by the subcutaneous injection of infectious material, all test and challenge inocula were administered by that route. The majority of Q fever infected guinea pigs showed strong febrile reactions for 4 or more days, often with an inflammatory, non-supurative lesion when injected subcutaneously, followed by recovery. The occasional fatal infections provided characteristic gross findings, and in these studies were transferred by spleen suspension.

ATTEMPTED TRANSMISSION BY MOSQUITOES

Following the discovery by Davis and Cox (1938) of the filterability of *C. burneti,* it was logical to try transmission through *Aëdes aegypti,* which have been shown to be experimental transmitters of a number of filterable agents. Uninfected colonies were allowed to bite infected guinea pigs during the initial one to three days of fever. The freshly gorged insects were selected by transmitted light, and transferred to new cages for incubation and subsequent test-feedings. A few freshly fed specimens of each lot were caught, stunned with tobacco smoke, ground in a mortar in saline, and the suspension immediately injected into fresh guinea pigs. In this way each of the lots reported below was proved to have ingested infectious blood from the donor animal. All caged lots were stored at room temperature, about 68°–75° F, throughout the tests.

Lot 1. January 2, 1937. Approximately 100 *aegypti* fed on an infected passage animal on the first day of fever. Ingestion of *C. burneti* was shown by immediate injection of 12 of these into a guinea pig which became infected, and later proved immune. After 12 and 16 days storage at room temperature, 38 and 26 mosquitoes fed on fresh guinea pigs. Intercurrent infection invalidated the first test. The second animal remained afebrile for 30 days and developed a characteristic febrile

Received for publication, May 3, 1948.

[1] From the Rocky Mountain Laboratory, Hamilton, Montana; Division of Infectious Diseases, National Institute of Health.

reaction when challenged with strain passage material. On the 24th day, the 12 mosquitoes remaining alive were injected into a fresh guinea pig, which showed a slight initial rise in temperature and then remained afebrile for 24 days. On challenge it was shown to be susceptible.

Lot 2. A donor animal was bitten on the third day of fever by approximately 75 mosquitoes. A pool of 10 freshly fed insects was shown to contain infection and the test animal was later shown to be immune. About 50 of these accepted a bloodmeal on the third day ofter their donor feed. This animal remained afebrile for 27 days and was then found to be susceptible on challenge. On the 15th day, 24 insects bit a fresh animal, which also remained afebrile for 30 days, and had a typical febrile course following challenge. On the 23rd day, 10 *aegypti* bit another guinea pig, and were then injected into a fresh animal. Both remained afebrile for 36 days and were not immune when challenged.

Lot 3. The donor for this lot was the animal used to prove ingestion of rickettsiae in Lot 2 by injection of blood engorged insects. It was bitten on the first day of fever by 125 *aegypti* of this lot. Fifteen of these produced infection when injected subcutaneously into a fresh animal immediately after feeding, and 11 more were also found to be infectious when injected into another animal 24 hours later. Test bitings on the 10th, 18th, and 30th days by 50, 28, and 14 insects were again negative. An animal bitten by 15 insects on the 24th day became febrile on the 7th day and 2 days later was sacrificed for passage. There was evidence of pneumonia in the lungs and the spleen was normal in size. Spleen passage to a second animal failed to cause infection, or immunity to subsequent challenge with infectious material. The 14 insects which fed on the 30th day were injected into a fresh animal, which showed a slight initial rise in temperature for 48 hours and then remained afebrile for 42 days. It developed a typical, febrile course when given an immunity test.

Lot 4. A fresh lot of approximately 100 *aegypti* was fed on the first day of fever of the second of the mosquito-injected (24-hour) animals in Lot 3 above. A test guinea pig each was infected by injection of 10 insects after periods of 24 and 48 hours but not at 96 hours. The first 2 resisted challenge after 25 and 24 post-febrile days, while the third was susceptible to the same challenge on its 32nd day after mosquito injection.

Lot 5. While the *aegypti* were being fed on the donor in Lot 4, 25 were gently interrupted when about half engorged and transferred to an immobilized guinea pig in another cage, using the aspirator technique described in similar interrupted feeding tests with tularemia and yellow fever (Philip, 1930; Philip, Davis, and Parker, 1932). Resumption of feeding on the test animal varied from immediately to not over 5 minutes delay. Injection of 10 of these into another guinea pig after completion of feeding showed them to have ingested rickettsiae. The test animal, after the interrupted insect feedings, remained afebrile for 30 days and was found to be susceptible on challenge.

Lot 6. Fourteen freshly engorged mosquitoes of 25 selected from Lot 4 survived puncture of the abdominal wall with a fine needle under tobacco anesthesia. This was an effort to duplicate observation of Merrill and Tenbroeck (1935) when they showed that equine encephalomyelitis virus could be caused to invade the

body cavity of mosquitoes by this technique. Fifteen days later 6 of these were induced to bite a fresh guinea pig, and were then injected into another. Neither animal showed febrile reaction during the next 21 days, and each was shown to be susceptible.

TITRATION OF TICK TISSUE

In view of the following summarized data on minute dosages of titrated infectious materials cited below, it seems remarkable that the contaminated mouth-parts of the 25 mosquitoes in Lot 5 above did not also infect the test animal on which they completed an interrupted feeding, since they were shown to have become infected. A part of these tests have been referred to by Cox (1940) (protocols of these tests will be reported elsewhere).

In 5 series of tests, nymphs of *D. andersoni* stored at room temperature for varying periods up to one month, after feeding on infected guinea pigs, then ground in saline to make one per cent suspensions by weight, contrifuged at approximately 1500 rpm in an angle centrifuge for 15 minutes, and decimally diluted in ascitic fluid, caused infection in dilutions up to 10^{-8} twice, and once each to 10^{-9}, 10^{-11}, and 10^{-12}.

In 2 series of tests, handled similarly but with the one per cent saline suspension first passed through Berkefeld N and W filters before serial dilution in ascitic fluid, the 10^{-8} dilution of each filtrate was infectious, the highest tested. The filtrates were consistently free of bacterial growth when cultivated in suitable media.

The highest titer encountered in any infectious material was the one referred to by Cox in dilutions of adult *D. andersoni* suspensions up to 2×10^{-12} (1 : 500 billion). These were adults that engorged as nymphs on infected guinea pigs. Transfer of one by spleen to 4 fresh animals resulted in typical febrile reactions after the more customary 3 to 5 days' incubation, and indurated, subcutaneous lesions again were observed. All four animals remained afebrile on immunity test.

In tests to be reported elsewhere there appeared to be a reduction in virulence of the rickettsiae in ticks fed optimally on donors injected with yolk sac culture material of strains passed for 99 and 115 consecutive passages in eggs by Cox. One series may be used for illustration. *D. andersoni* nymphs fed throughout 4 days of fever on a donor injected with "yolk sac virus" of the 115th passage. Two fresh guinea pigs each received 2 freshly engorged nymphs. They developed 2 and 3 days of fever only, without subcutaneous lesions, after 10 and 12 days' incubation. Both were later immune. After storage at room temperature and molting, 12 resulting adults were given partial feedings on a guinea pig, and half were pooled and injected into 2 fresh animals, the remaining 6 ticks into 2 others. The bitten animal and all 4 injected animals became febrile after 9 and 10 days, recovered, and were subsequently proven immune; and only 2 developed small subcutaneous lesions.

This difference in virulence has been confirmed in other tests and it appears more probable that it was due to changes in egg-adapted strains than to differences in handling of the ticks.

MECHANICAL TRANSMISSION BY HAEMATOPHAGOUS BUGS

A colony of uninfected *Triatoma infestans* was originally supplied by Dr. E. Dias of Oswaldo Cruz Institute, Rio de Janeiro. Two late stage nymphs and one

adult were allowed a partial meal directly on an inflammatory "skin lesion" of a tick feces injected donor during the fourth day of fever. Each bug was interrupted during feeding and allowed to continue feeding on the clipped belly of a clean, immobilized animal. A second interrupted feeding with the same insects, before they were satiated, was then accomplished between the donor and another test animal. Both test animals became infected, showing a febrile rise after 4 and 5 days, and both recovered without signs of a cutaneous lesion. They remained afebrile when given later immunity tests.

TICK FECES

Fecal pellets were recovered from capsules in which adults of *D. andersoni* were being fed on guinea pigs and stored in pill boxes in 70 per cent humidity jars at room temperature. Such feces are very rich in rickettsiae, as demonstrated by several facts: microscopic demonstration of an abundance of organisms in prepared smears, high titers shown by titration, use of tick feces for preparation of effective antigens for serological tests (Cox, 1940) and computation on the basis of complement fixation by Dr. David B. Lackman (unpublished) of approximately 10 per cent of the total nitrogen in feces stored for 5 years and 11 months as rickettsial in nature. Smears of one per cent washed and centrifuged preparation of the latter feces still showed an average of 50 well defined rickettsiae per highpower field.

Weighed samples of feces, suspended in saline, and decimally diluted in ascitic fluid, have given titers of 10^{-9} and 10^{-10} in three series of tests. The agent is very resistant in tick feces. Samples stored as above have been found to be infectious for the following periods (in days): 2, 59, 119, 127, 214, 217, 354, 485, and 586.

A sample, a part of which had previously proved infectious at 59 days, was held through the war period during the absence of the writer, and tested after 5 years and 11 months' storage by injection into 2 guinea pigs. Each of 4 guinea pigs injected with 1.5 cc saline suspension developed low fever for one to 3 days within 4 days of inoculation. Three returned to normal for 16 days, and when challenged 2 developed low fevers, the third none, thus showing some immunity compared to the characteristically more severe reactions in the controls. Blood transfer into developing chick eggs and to fresh guinea pigs was negative from one of these which showed 40° C on the 4th day after initial injection. The fourth of the original animals was sacrificed on the third day with temperature of 40.2° C. At autopsy the lungs were clear, spleen appeared slightly enlarged. Blood clots were ground and passed into embryonated chick eggs and 2 guinea pigs, and a pool of spleen, liver and tunica into 2 other animals, all with negative results, and all animals were susceptible to challenge. The chick embryos were transferred serially by blind passage twice without recovery of a strain.

In another series testing tick feces stored from August 8, 1938, to October 17, 1946 (over 8 years), the 2 guinea pigs injected with 1.5 cc saline suspension remained afebrile 19 days, were then challenged, and were found to be completely immune.

A further attempt was made to recover a strain by injection of a filtered saline suspension of one of these samples, directly into developing chick eggs. Further blind-passage in eggs failed to provide evidence of infection.

Frank febrile reactions have been produced in the following guinea pigs, which were administered the proved infectious fecal samples by the routes listed: powdered feces at base of hair on unbroken skin, 2; same, feces moistened with ascitic fluid *in situ,* 2; feces rubbed on sacrificed skin, 2; powdered feces dusted in nostrils, 4; and on conjunctivae of eyes, 2; and saline moistened pellets in mouth, 1. The last test animal died on the 17th day without enlarged spleen or other evident cause of death at necropsy. Spleen transfer to two other animals caused severe febrile reactions, and they were both immune when challenged with infectious material. One "abraded skin," test animal also died on the 32d day; necropsy findings revealed spleen enlarged three and one-half times and inguinal nodes enlarged and injected. The other guinea pigs showed the usual febrile course and remained afebrile when given immunity tests. Those animals receiving applications of feces to the skin were protected from subsequent oral contamination by putting wire gauze capsules, held in place by adhesive tape, over the sites of application.

Parallel tests for certain of these methods were made using spleen tissue from infected animals sacrificed after 4 to 5 days of fever. In two cases, the spleen pulp was rubbed carefully onto the skin at the base of parted hair between the shoulder blades. In two others, the ground spleen was suspended in saline, and drops carefully deposited on the skin in the same location. Each animal was kept under observation until the applications had become relatively dry, and then the area was covered by loose adhesive tape patches on the hair. The animals were kept separately, as usual, and it is considered that they had not had opportunity for oral contamination. Three of the 4 animals developed febrile reactions after 8 to 10 days' incubation, and were immune when challenged. The fourth, which had been most lightly rubbed with spleen tissue, remained afebrile for 27 days and was susceptible on challenge. Two other guinea pigs also became infected which had received the same spleen material on scarified skin, one by vaccination, the other the suspension. Approximately 2 cc of the above spleen suspension was administered through a rubber catheter of suitable size directly into the stomach of another guinea pig. This animal remained afebrile following both inoculations and the immunity test on the 27th day, whereas controls showed typical febrile reactions.

INFECTION IN UNFED, REFRIGERATED *D. andersoni*

Nymphal *D. andersoni* were placed on 3 donor guinea pigs for infected bloodmeals, March 19, 1938. They molted to adults while stored at room temperature. On August 1 they were transferred to a cold room and stored at approximately 35° F. After the adult ticks had been chilled for 63 days, 7 guinea pigs were each injected with the viscera of one tick (three from one donor and four from another). All but one developed severe febrile reactions within 24 hours, and 4 had characteristic indurated, subcutaneous lesions. Six died in 7, 8, 9(2), 20 and 22 days, showing characteristic necropsy findings. The seventh animal developed high fever of 5 days after 7 days' incubation and recovered. It had 3 days of 39.8–40° F following immunity test in which controls showed characteristic high fevers. After 129 days in the cold room, ticks from 2 donors were again removed, and 3 from each lot were used for immediate, separate injection into 6 fresh guinea pigs, one tick per animal as above. All 6 guinea pigs had immediate febrile responses, beginning in 24 hours, and developed indurated subcutaneous lesions in 48 to 72 hours;

only one recovered. It was subsequently immune to challenge. Three died on the 10th, 11th, and 17th days, respectively, again showing characteristic gross lesions at autopsy. The two remaining animals were sacrificed when moribund on the 8th day, also revealing characteristic gross pathology.

TRANSMISSION EXPERIMENTS WITH HOUSEFLIES

Exp. 1. On May 13, 1937, during early efforts to trace the cause of sporadic appearance of Q fever in guinea pigs under observation for tests not concerned with that disease, 34 houseflies were netted at large in the room. There had been opportunity for them to have come in contact in the same room with Q fever-infected animals. The flies were stunned with tobacco smoke, and triturated in Tyrode's solution. The suspension was then centrifuged at approximately 1500 rpm for 10 minutes. The middle layer of the supernate was carefully drawn off and 2 cc injected into each of 2 fresh guinea pigs. Each animal developed characteristic, indurated subcutaneous lesions, beginning on the 3rd and 4th days, and febrile reactions started on the 3rd and 6th days, respectively. One was sacrificed on the 5th day of fever; stained impressions of the "skin lesion" showed an abundance of rickettsia-like organisms. The spleen was about three and one-half times enlarged, and it was passed to 3 fresh guinea pigs. Each of these developed fever on the 3rd or 4th day, which lasted for 5 to 6 days, and the temperatures of all 3 returned to normal. These 3 and the remaining original test animal remained afebrile when challenged with controlled strain passage inocula.

Infection was demonstrated under essentially the same conditions with 13 flies taken later in the same room.

Exp. 2. Feces from *Dermacentor andersoni,* which had been proven to be infectious, were moistened with Tyrode's and exposed overnight in a cage with houseflies. Two of these flies were then stunned with tobacco smoke, their legs and wings removed, given 3 violent washings in saline in a flask, ground in Tyrode's and 1 cc injected into a clean guinea pig. This animal developed 3 days of fever, beginning on the 10th day, and returned to normal temperature. It remained afebrile when challenged twenty-four days later.

Exp. 3. An enlarged macerated spleen of a guinea pig sacrificed during fever was exposed in a cage of houseflies for 2 hours. The next day 37 of these flies were treated as in Exp. 2, lightly centrifuged, and 1 cc of the suspension was injected into a test animal. It developed 4 days of fever, beginning on the 10th day, and returned to normal. It remained afebrile when challenged 23 days later.

Exp. 4. Partially mature maggots were permitted to feed on triturated infectious spleen tissue overnight in a Petri dish, and pinkish ingested food could be seen through the integument of the maggots. After completing their development in non-infectious food material, 5 of the resulting flies were emulsified and injected into a fresh guinea pig. No reaction developed for 21 days, and this guinea pig was shown to be susceptible to Q fever.

Exp. 5. A controlled experiment in a large screen cage was set up to test possible transfer of infection by flies permitted free access to a large can used to hold 3 successive groups of 4 infected guinea pigs each, and to another can used for 2 successive groups of 4 uninfected animals each. Handling, feeding, and temperature-taking was managed so that the only possible manner by which the test ani-

mals could become contaminated was by the flies. The donor groups of animals were exposed for the entire courses of their febrile periods. Observations were conducted over a period of 43 days in the cage, during which the 3 "generations" of infected animals were exposed. Three of the eight test animals died of intercurrent causes and were not transferred. All the other 5 animals remained afebrile for 19 or 29 day periods and developed febrile reactions and subcutaneous lesions when challenged. This was in spite of the fact that 20 flies removed from the cage during the course of the experiment produced characteristic though nonfatal infections in 4 guinea pigs into which they were injected in groups of 5 each. All animals were shown to be immune.

Four groups of 5 maggots from the cans in which the donors were kept were removed during the febrile course in the second group of donors. Each group was kept in a Petri dish overnight to permit purging, and was then washed vigorously in 3 changes of saline, ground in Tyrode's in separate groups, and each group was injected into a separate test guinea pig. Except for low initial fevers in two, none developed a suspicious pyrexial course during 20 days of observation, and all were proven susceptible in challenge.

Exp. 6. The same experimental cage was used and 5 successive groups of 2 to 4 infected donors were again introduced into the "infected can" during their febrile episodes. Flies were present in abundance. Four test animals were kept under observation in the adjoining can for a period of 55 days, during which time flies were permitted to breed and move freely between cans. One of these animals developed occasional sporadic fevers, and all were susceptible when finally challenged.

The fly stock for this experiment was obtained through the courtesy of Dr. W. V. King, Orlando, Florida.

SUMMARY AND CONCLUSIONS

1. *Coxiella burneti* does not appear to be transmissible by *Aëdes aegypti,* either mechanically by interrupted, but undelayed feedings, between donor and susceptible guinea pigs, or when refeeding was delayed for as long as 10 days to a month. At temperatures of 68° to 75°, the rickettsiae did not persist in the bodies of the insects for any considerable periods, even when the gut wall of freshly fed mosquitoes was punctured.

2. In titration experiments with the tissues and feces of *Dermacentor andersoni,* it was found that minute dosages were infectious, the respective maximum titers being 2×10^{-12} (1 : 500 billion) and 10^{-10}. Saline suspensions of tick tissue, filtered through Berkefeld N and W candles, still titered to 10^{-8}, the highest dilution tried.

3. Feces from infected *D. andersoni* are very rich in rickettsiae, and the latter persisted in an infectious state in feces stored for as long as 586 days. Feces stored at room temperature and 70 per cent humidity for nearly 6 years still showed recognizable organisms on microscopic examination, antigenicity in serological tests, and immunized injected animals, but no strains were recovered in animals or embryonated hens' eggs.

4. Infection from tick feces, and from infected guinea pig spleen pulp and spleen emulsion penetrated the unbroken skin, as well as the abraded skin of test animals.

Animals also became infected when powdered feces were dusted in the nostrils, eyes, and mouth in separate tests.

5. The rickettsia in adults of *D. andersoni* infected in the previous nymphal stage, and stored after molting for 65 and 127 days in a cold room at about 35° F, was highly virulent when single ticks were injected immediately on removal from chilling. Most of the test animals died after severe febrile courses and short incubation periods. This indicates another difference between *C. burneti* and *Rickettsia rickettsi* of Rocky Mountain spotted fever, which requires "reactivation" before the infection in chilled, fasting ticks reaches maximum level of virulence.

The high degree of infectiousness of the rickettsia in the former ticks is in contrast to experience with ticks infected on animals injected with yolk-sac adapted strains of 97 to 115 serial transfers in eggs.

6. Infection was recovered from housefiies, *Musca domestica,* caught at large in an animal room in which Q fever infected animals were kept. However, attempts failed to transfer infection from infected to normal guinea pigs kept separately, but in a common cage in which houseflies had free access to both.

7. Houseflies allowed to feed on moistened, infectious tick feces, and on infected spleen pulp, were found to be contaminated with *C. burneti* when injected into test animals.

References

Cox, H. R. 1940 *Rickettsia diaporica* and American Q fever. Am. J. Trop. Med. **20**: 463–469.

Davis, G. E. and Cox, H. R. 1938 A filter-passing infectious agent isolated from ticks. Isolation from *D. andersoni,* reactions in animals, and filtration experiments. Public Health Reports **53**: 2259–2267.

Merrill, M. H. and Tenbroeck, C. 1935 The transmission of equine encephalomyelitis virus *Aëdes aegypti.* J. Exp. Med. **62**: 687–695.

Philip, C. B. 1930 Possibility of mechanical transmission by insects in experimental yellow fever. Ann. Trop. Med. and Parasitol. **24**: 493–501.

———1948 Comments on the name of the Q fever organism. Public Health Reports **63**: 58.

———, Davis, G. E., and Parker, R. R. 1932 Experimental transmission of tularemia by mosquitoes. Public Health Reports **47**: 2077–2088.

NEW NORTH AMERICAN CHIGGERS (ACARINA, TROMBICULIDAE)[1]

JAMES M. BRENNAN

United States Public Health Service

The larvae of seven new species of trombiculid mites (*Neoschöngastia fullbergae, Euschöngastia cordiremus, E. criceticola, E. lacerta, E. luteodema, E. miricoxa,* and *Trombicula jamesoni*) are described. All measurements are given in microns.

Neoschöngastia fullbergae n. sp.
(Figs. 1 and 8)

Larvae, in life, orange, broad-elliptical.

Size: Length, 500 to 643; width, 316 to 408.

Capitulum (Fig. 1, B): Chelicerae moderately long, stout, with distinct subapical ventral tooth and inconspicuous dorsal tooth. Cheliceral base longer than wide, with few scattered punctations. Galeal seta forked or with two branches. Palpal claw trifurcate, the median prong largest; thumb with seven branched setae and a spur of moderate length; all palpal setae branched except the dorsal seta on article 4 which is either nude or forked.

Scutum (Figs. 1-A and 8): Scutum punctate, as figured; about one and one-third times wider than long; roughly trapezoidal in shape with rounded, unexpanded corners and with poorly defined margins because of the encroachment of cuticular striae which, from the posterior margin, are projected perpendicularly on to the scutum between and as far as the sensillary bases. Setae plumose, all of similar form; length of anteromedian, anterolaterals and posterolaterals increases in the order cited. Sensillae capitate; the round head with few large, flattened setules; stem long, bare. Sensillary bases separated by somewhat more than the distance between anterolateral and posterolateral setae, and located far anterior to the posterolaterals.

Standard measurements: Holotype: AW–57, PW–76, AP–36, SB–40, ASB–33, PSB–26, AM–36, AL–48, PL–52, S–32, DS–40 to 44. Average of ten specimens: AW–56, PW–72, AP–33, SB–39, ASB–29, PSB–26, AM–32, AL–50, PL–56, S–32 (average of four), DS–40 to 45.

Dorsum (Fig. 1, D): Eyes 2/2, in ocular plate. Dorsal formula fairly constant, 2–8–6–6–4–2–2; the setae decreasing in length from anterior to posterior rows.

Venter (Fig. 1, C): Two pairs of sternal setae. Ventrals 32 to 36, those posterior to the anus longest and similar in form to the dorsal setae.

Legs: All legs with seven segments. Coxal setae, 1–1–1.

Type data: Holotype and 15 paratypes, larvae from *Odocoileus hemionus hemionus* (Rocky Mountain mule deer), Sula, Montana, July 15, 1947, W. L. Jellison, AP23827.

Holotype and seven paratypes deposited in the collection of the Rocky Mountain Laboratory, four paratypes in the United States National Museum, two paratypes in the British Museum (Natural History), and two paratypes in the South Australian Museum, Adelaide.

The presence of only one seta on coxa III, the shape of the scutum, the relatively few cuticular striae which encroach on the scutum, and in addition its host preference for deer distinguish *Neoschöngastia fullbergae* from the only other recognized North American species, *N. americana* (Hirst).

This species is named for Miss Roma Fullberg, Biological Aide at the Rocky Mountain Laboratory, who first observed and recovered specimens from the host.

Received for publication, May 3, 1948.

[1] From the Rocky Mountain Laboratory, Hamilton, Montana, Division of Infectious Diseases, National Institutes of Health.

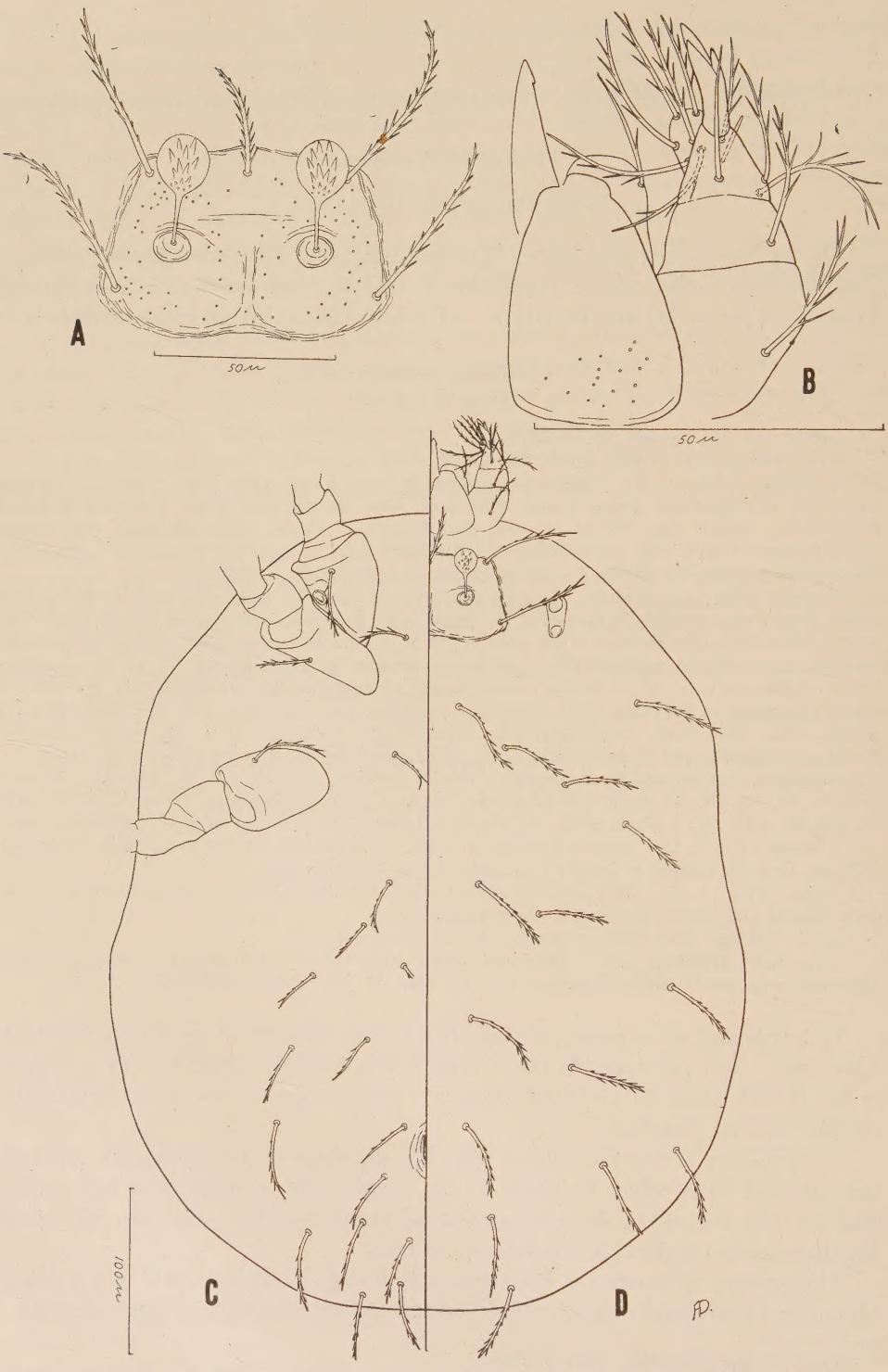


FIG. 1. *Neoschöngastia fullbergae* n. sp. A. Scutum. B. Dorsal view of capitulum. C. Venter. D. Dorsum.

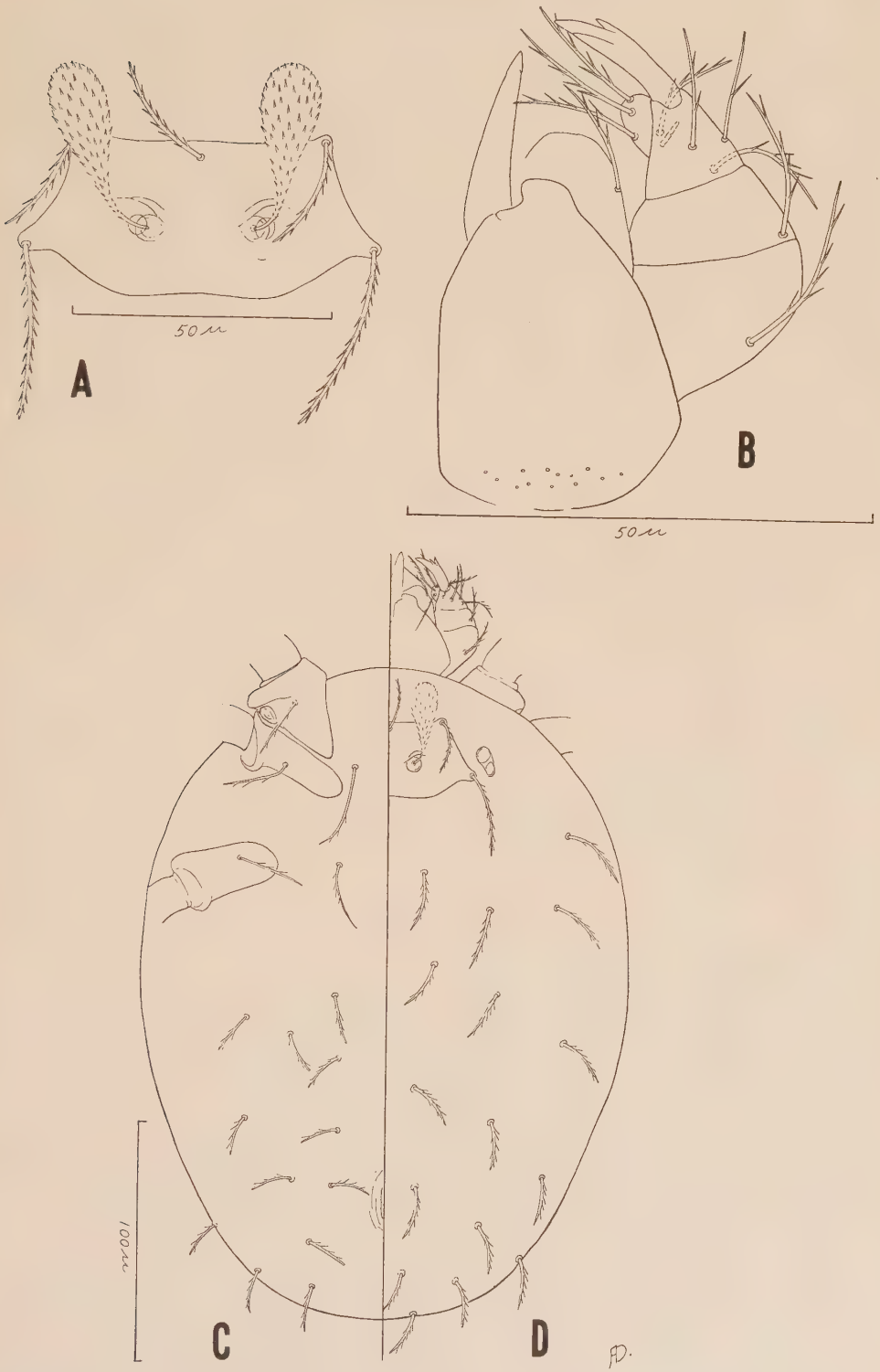


FIG. 2. *Euschöngastia lacerta* n. sp. A. Scutum. B. Capitulum, dorsal view. C. Venter. D. Dorsum.

Euschöngastia lacerta n. sp.
(Figs. 2 and 9)

Larvae, engorged, oval, quite small.

Size: Length, 260 to 475; width, 175 to 325.

Capitulum (Fig. 2, B): Chelicerae fairly short, broad, with subapical ventral tooth and indistinct dorsal tooth. Base of chelicerae a little longer than wide, with few punctations basally. Galeal seta branched. Palpal claw trifurcate; thumb with four branched setae and a short spur; all palpal setae branched, the dorsal seta and lateral seta on article 4 having but one or two branches.

Scutum (Figs. 2-A and 9): Scutum apparently without punctations; about twice as wide as long; the anterior margin nearly straight, the posterior margin a broad reverse curve with the ends concave forward; angles prominently expanded. Setae plumose, similar in form; length of anterolaterals, anteromedian and posterolaterals increases in the order cited. Sensillae spatulate-clavate, broadest at the distal quarter; head with numerous, regularly distributed setules which continue down the stem nearly to the base. Sensillary bases separated by slightly less than the distance between anterolateral and posterolateral setae and located anterior to a line between the posterolateral setae.

Standard measurements: Holotype: AW–48, PW–70, AP–24, SB–22, ASB–20, PSB–17, AM–27, AL–21, PL–35, S–35, DS–18 to 27. Average of four specimens: AW–48, PW–71, AP–24, SB–23, ASB–21, PSB–15, AM–26, AL–21, PL–35, S–35, DS–17 to 27.

Dorsum (Fig. 2, D): Eyes 2/2, in ocular plate. Dorsal formula, 2–6–6–6–4–2; the setae quite small, and decreasing in length from anterior to posterior rows.

Venter (Fig. 2, C): Two pairs of sternal setae, about equal in length. Ventrals 18 to 22, four of these being posterior to the anus and similar in form to the dorsal setae.

Legs: Seven-segmented. Coxal setae, 1–1–1.

Type data: Holotype and 3 paratypes, larvae from *Sceloporus occidentalis occidentalis* (Pacific fence lizard), Camp McQuaide, Santá Cruz County, California, August 15, 1945, William Lewellen, AP22003.

Holotype and one paratype deposited in the collection of the Rocky Mountain Laboratory and two paratypes in the United States National Museum.

This species is readily separated from other Nearctic species by the shape of the scutum and sensillae, the trifurcate palpal claw, and the dorsal formula (the number of setae considerably less than usual).

Euschöngastia lacerta was found in association with numerous specimens of *Eutrombicula alfreddugesi* (Oudemans).

Euschöngastia miricoxa n. sp.
(Figs. 3 and 10)

Larva, engorged, broad-oval, fairly large.

Size: Length, 867; width, 602.

Capitulum (Fig. 3, B): Chelicerae short, robust, with small subapical ventral tooth and indistinct dorsal tooth. Cheliceral base little longer than wide; punctate. Galeal seta nude. Palpal claw with five prongs; thumb with six branched setae and a long spur; seta on palpal article 2, dorsal and ventral setae on article 4 branched; seta on article 3 and lateral seta on article 4 are broken on both palpi of the single specimen studied.

Scutum (Figs. 3-A and 10): Scutum punctate; at least twice as wide as long, with sinuous anterior and posterior margins, as figured, and the very short lateral margins distinctly incurved. Setae plumose, long, slender; the posterolaterals nearly twice as long as the anterolaterals; anteromedian broken. Sensillae broken. Sensillary bases separated by little more than two times the distance between anterolateral and posterolateral setae, and located far posterior to the posterolaterals.

Standard measurements: Holotype: AW–79, PW–98, AP–17, SB–38, ASB–40, PSB–14, AM––, AL–59, PL–112, S––, DS–70 to 81.

Dorsum (Fig. 3, D): Eyes not discernible, but probably present. Dorsal formula irregular because of interpolated setae, 2–17–13–11–8–4–2. Setae long, thin, and decreasing slightly in length from anterior to posterior rows.

Venter (Fig. 3, C): Two pairs of sternal setae, the anterior pair the longer. Ventral setae about 60, arranged in irregular rows, those posterior to the anus largest.

Legs: Seven-segmented. Coxal setae 1–1–1. Coxa I (Fig. 3, E) broadened distally, proximal half stem-like.

Type data: Holotype, larva from *Myotis lucifugus lucifugus* (little brown bat), Tompkins County, New York, August 5, 1947, W. J. Hamilton, Jr., AP24006. Deposited in the collection of the Rocky Mountain Laboratory.

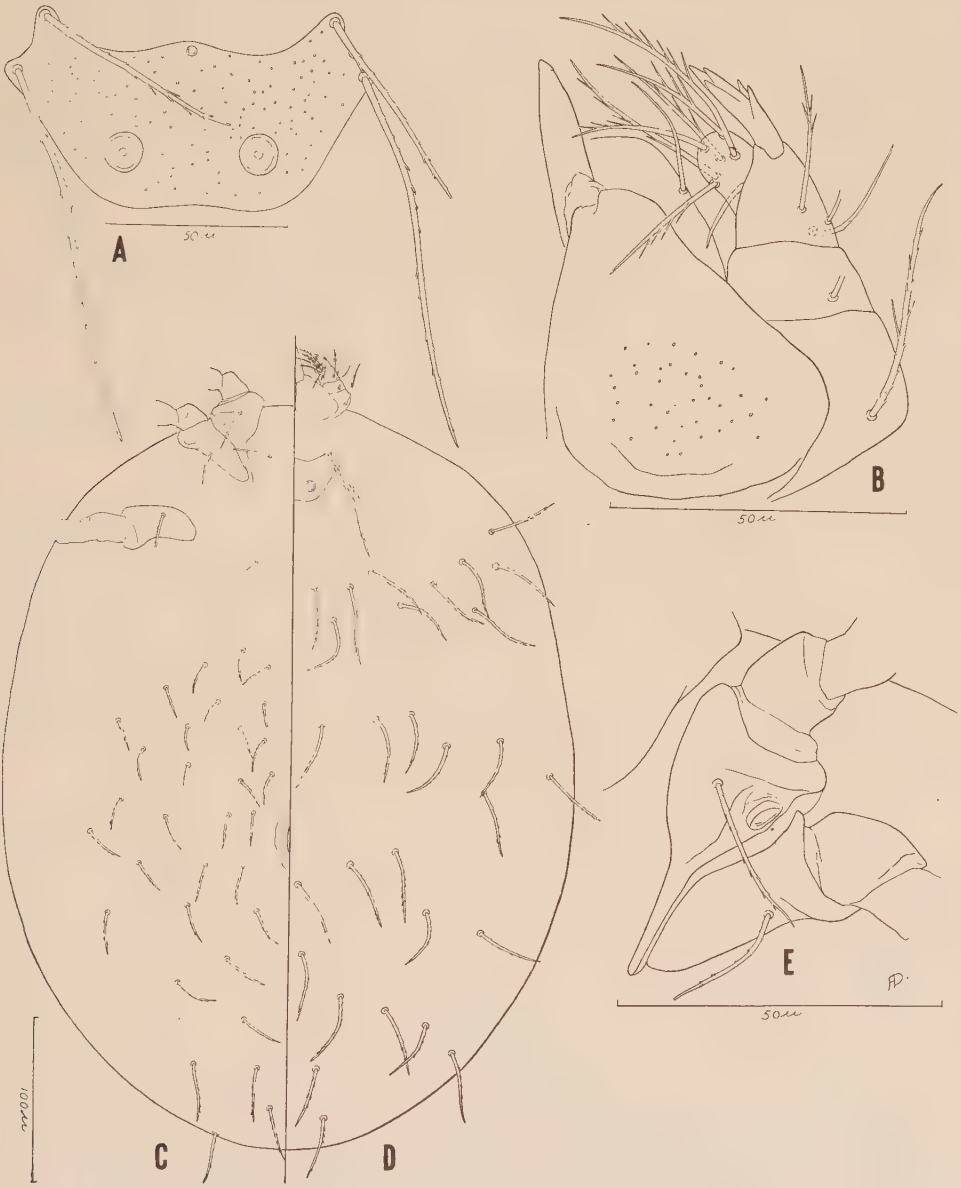


FIG. 3. *Euschöngastia miricoxa* n. sp. A. Scutum. B. Capitulum, dorsal view. C. Venter. D. Dorsum. E. Coxae I and II.

Although the sensillae are lacking in the single specimen of the description, *miricoxa* is tentatively placed in the genus *Euschöngastia* as suggested by the shape of the scutum and correlated five-pronged palpal claw. The long stem-like basal half of coxa I and the deep scutum with short, constricted lateral margins should readily distinguish this from other Nearctic species.

Euschöngastia cordiremus n. sp.
(Figs. 4 and 11)

Larvae, in life, yellow, oval.

Size: Length, 290 to 570; width, 180 to 375.

Capitulum (Fig. 4, A): Chelicerae with small subapical ventral and dorsal tooth. Base of chelicera longer than wide and with numerous, conspicuous punctations. Galeal seta branched. Palpal claw trifurcate; thumb with six branched setae and a short spur; all palpal setae branched.

Scutum (Figs. 4-B and 11): Scutum punctate; about twice as broad as long; anterior and posterior margins sinuous, as figured; lateral margins very short, mildly incurved; angles expanded. Sensillae cordate; head with numerous, regularly distributed setules; the short stem without vestiture. Sensillary bases separated by about twice the distance between anterolateral and posterolateral setae and located far posterior to a line between the posterolateral setae; a conspicuous, inverted U-shaped, integumental fold anterior to each sensillary base. Setae plumose, similar in form, the anteromedian and anterolaterals subequal in length, the posterolaterals much longer.

Standard measurements: Holotype: AW–58, PW–69, AP–15, SB–32, ASB–28, PSB–9, AM–26, AL–26, PL–45, S–27, DS–36 to 45. Average of 10 specimens: AW–49, PW–62, AP–13, SB–24, ASB–27, PSB–11, AM–26, AL–27, PL–45, S–29, DS–35 to 44.

Dorsum (Fig. 4, D): Eyes 2/2, no ocular plate. Dorsal formula quite variable, but approximately 2–10–10–2–10–8–2–4–2. Setae similar in form to those of the scutum, decreasing slightly in length from anterior to posterior rows.

Venter (Fig. 4, C): Sternal setae, six; two in the anterior row, four in the posterior row; the anteriors are the longer. Ventral setae more than 50, in irregular rows, those posterior to the anus longest.

Legs: Seven-segmented. Coxal setae 1–1–1.

Type data: Holotype, larva from *Peromyscus maniculatus artemisiae* (sagebrush white-footed mouse), Gird Creek, Ravalli County, Montana, February 6, 1946, AP22130. Paratypes, two larvae, same data as holotype; two larvae, same host, Peaceful Valley, Ravalli County, Montana, October 10, 1945, AP22030; five larvae, same host, East Fork Drainage, Ravalli County, Montana, October 16–17, 1945, AP22037 and AP22041; six larvae from *Citellus lateralis tescorum* (Hollister mantled ground squirrel), Skalkaho Creek, Ravalli County, Montana, May 10, 1945, AP21806. All collections by personnel of the Rocky Mountain Laboratory.

Holotype and seven paratypes deposited in the collection of the Rocky Mountain Laboratory, four paratypes in the United States National Museum, two paratypes in the British Museum (Natural History) and two paratypes in the South Australian Museum, Adelaide.

Euschöngastia cordiremus has affinities with *E. peromysci* (Ewing) in the shape and standard measurements of the scutum, structure and vestiture of the capitulum, arrangement and number of dorsal setae, etc., but is easily separated from the Ewing species by the greater number of sternal setae and the shape of the sensillae (cordiform, i.e. with flattened or truncate tips in *cordiremus;* capitate, i.e. with rounded tips in *peromysci*).

Euschöngastia luteodema n. sp.
(Figs. 5 and 12)

Larvae, in life, pale yellow, well-rounded when engorged, occasionally wider than long.

Size: Length, 315 to 680; width, 240 to 635.

Capitulum (Fig. 5, A): Chelicerae of moderate length with a conspicuous subapical ventral tooth and much smaller dorsal tooth. Base of chelicera longer than wide, impunctate. Galeal seta forked, or sometimes with a few branches. Palpal claw with three prongs, the median prong largest; thumb with seven branched setae and a short spur; all palpal setae branched except the lateral seta on article 4 which is nude, rarely forked.

Scutum (Figs. 5-B and 12): Scutum impunctate; about two and one-half times wider than long; roughly hexagonal in shape, as figured, the posterior margin forming three of the sides, the short lateral margins two and the sinuous anterior margin one. Setae plumose, the anteromedian and anterolaterals subequal in length, the posterolaterals much longer. Sensillae broad spatulate-clavate to oblanceolate-clavate; the head with numerous, evenly distributed setules; the stem bare. Sensillary bases separated by approximately one and one-half times the distance

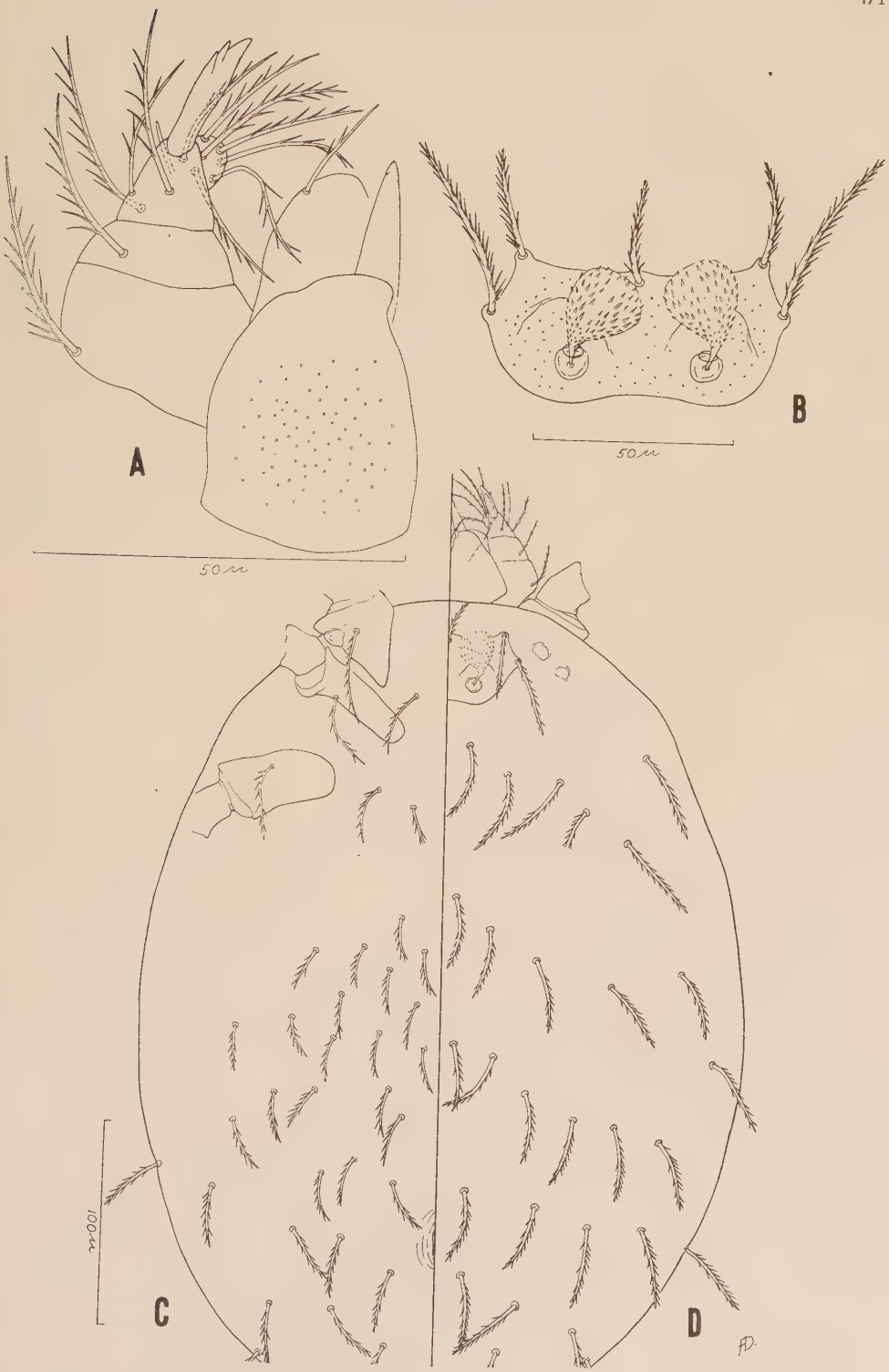


FIG. 4. *Euschöngastia cordiremus* n. sp. A. Capitulum, dorsal view. B. Scutum. C. Venter. D. Dorsum.

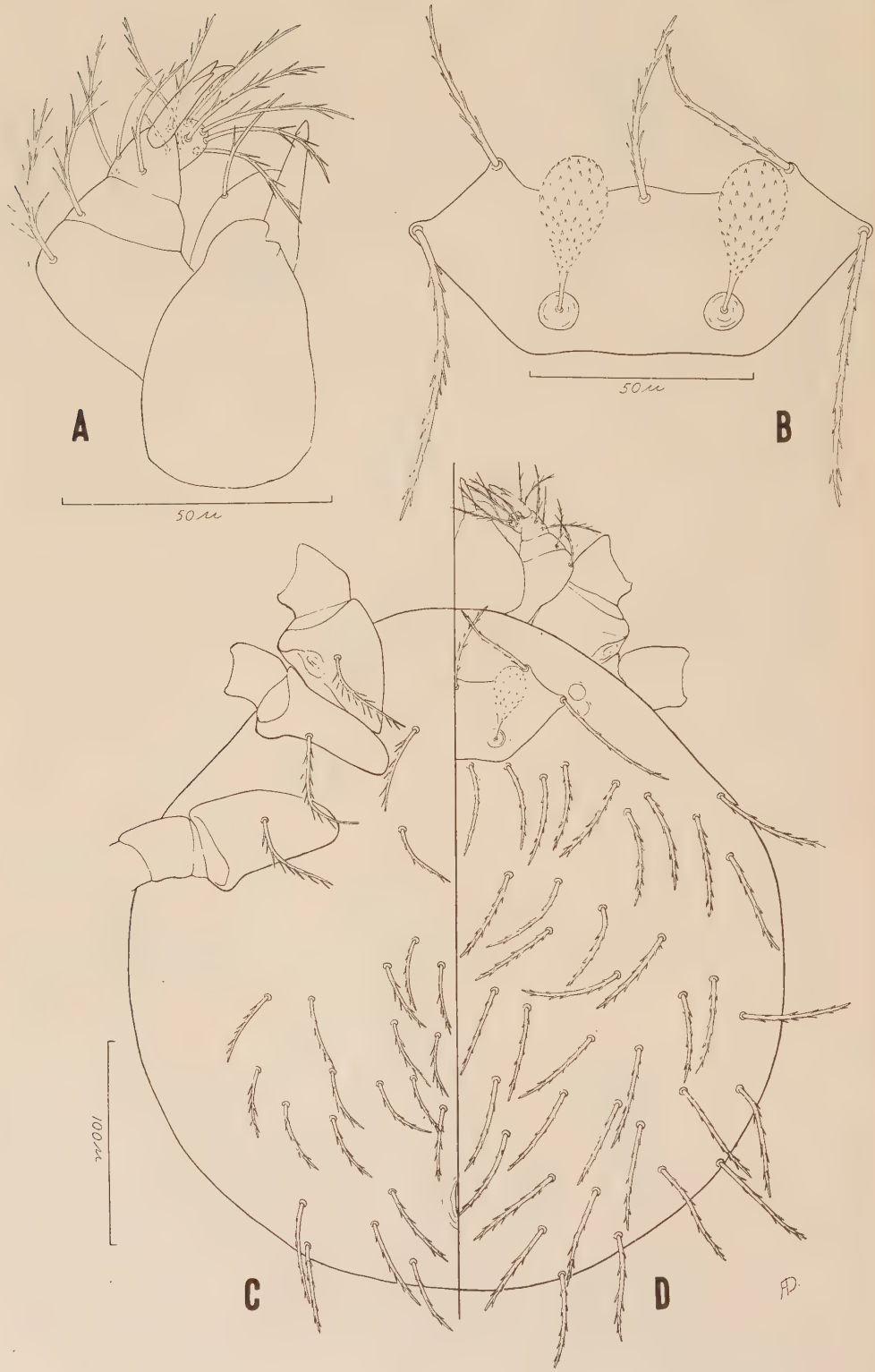


FIG. 5. *Euschöngastia luteodema* n. sp. A. Dorsal view of capitulum. B. Scutum. C. Venter. D. Dorsum.

between anterolateral and posterolateral setae and placed far posterior to a line between the posterolaterals.

Standard measurements: Holotype: AW–71, PW–99, AP–21, SB–36, ASB–31, PSB–10, AM–39, AL–41, PL–65, S–40, DS–40 to 52. Average of ten specimens: AW–68, PW–98, AP–21, SB–36, ASB–32, PSB–11, AM–38, AL–42, PL–64, S–40, DS–40 to 52.

Dorsum (Fig. 5, D): Eyes 2/2, no ocular plate. Dorsal setae usually more than 50, sometimes as many as 70, decreasing in length from anterior to posterior rows. No well defined dorsal formula because of the interpolation of partial secondary rows of setae. However, distinct zones of setae are apparent. The approximate formula for these zone-rows in the holotype is 2–19–20–13–9–2–2. The first zone-row may have as few as 13 setae or as many as 24.

Venter (Fig. 5, C): Two pairs of sternal setae, the anterior pair the longer. Ventrals about 40, in irregular rows.

Legs: All legs with seven segments. Coxal setae 1–1–1.

Type data: Holotype, larva from *Marmota flaviventer nosophora* (golden mantled marmot), Ross' Hole, Ravalli County, Montana, July 30, 1945, AP21926. Paratypes, seven larvae, same data as holotype; nine larvae, same host, Corvallis, Montana, May 2 and July 17, 1945, AP21800 and AP21898; eight larvae, same host, Skalkaho Creek, Ravalli County, Montana, April 15 and May 17, 1945, AP21699 and AP21817; four larvae, same host, Willow Creek, Ravalli County, Montana, March 28, 1946, AP22255; three larvae, same host, Fairfield, Camas County, Idaho, June 30, 1945, AP21851; one larva, same host, Falls Creek, Elmore County, Idaho, June 27, 1945, AP21852; one larva from *Citellus columbianus columbianus* (Columbian ground squirrel), Canyon Creek, Ravalli County, Montana, May 10, 1945, AP21809; seven larvae from *Tamiasciurus hudsonicus richardsoni* (Richardson pine squirrel), Sula, Montana, March 27, 1946, AP22254. All collections by personnel of the Rocky Mountain Laboratory.

Holotype and 20 paratypes deposited in the collection of the Rocky Mountain Laboratory, ten paratypes in the United States National Museum, five paratypes in the British Museum (Natural History), and five paratypes in the South Australian Museum, Adelaide.

Euschöngastia luteodema occurs in abundance on the marmot in association with *E. sciuricola* (Ewing) from which it is easily distinguished by the shape of the scutum and sensillae, greater number of dorsal setae and trifurcate palpal claw (usually five-pronged in *sciuricola*). With little experience, it is relatively simple to separate the living larvae without the aid of a lens. *E. luteodema* has a characteristic pale yellow color while *E. sciuricola* is considerably darker, almost brown yellow in color.

E. luteodema bears a strong resemblance to *E. guntheri* (Radford) by the shape of the scutum and sensillae and the numerous dorsal setae arranged in irregular zone-rows. The Radford species differs principally in having the cheliceral bases punctate. The lectotype has six sternal setae (two anterior, four posterior), and two setae on coxa III. While the number of sternals varies in other specimens of the *guntheri* type series, the two setae on coxae III are fairly constant.

Euschöngastia criceticola
(Figs. 6 and 13)

Larvae, in life, yellow, oval.

Size: Length, 235 to 449; width, 163 to 296.

Capitulum (Fig. 6, B): Chelicerae short, broad, with small subapical ventral and dorsal tooth. Base of chelicera larger than broad, impunctate. Galeal seta branched. All palpal setae branched, except the lateral seta on article 4 which is usually forked and may be bare; palpal claw trifurcate, rarely with more than three prongs; thumb with seven branched setae and a short spur.

Scutum (Figs. 6-A and 13): Scutum impunctate; slightly more than twice as wide as long; shaped as figured, the anterior and posterior margins as parallel reverse curves, lateral margins short, incurved. Setae plumose, similar in form; length of anteromedian, anterolaterals and posterolaterals increases in the order cited. Sensillae broad spatulate-clavate; head with numerous small setules which are more densely distributed basally and continue for a short

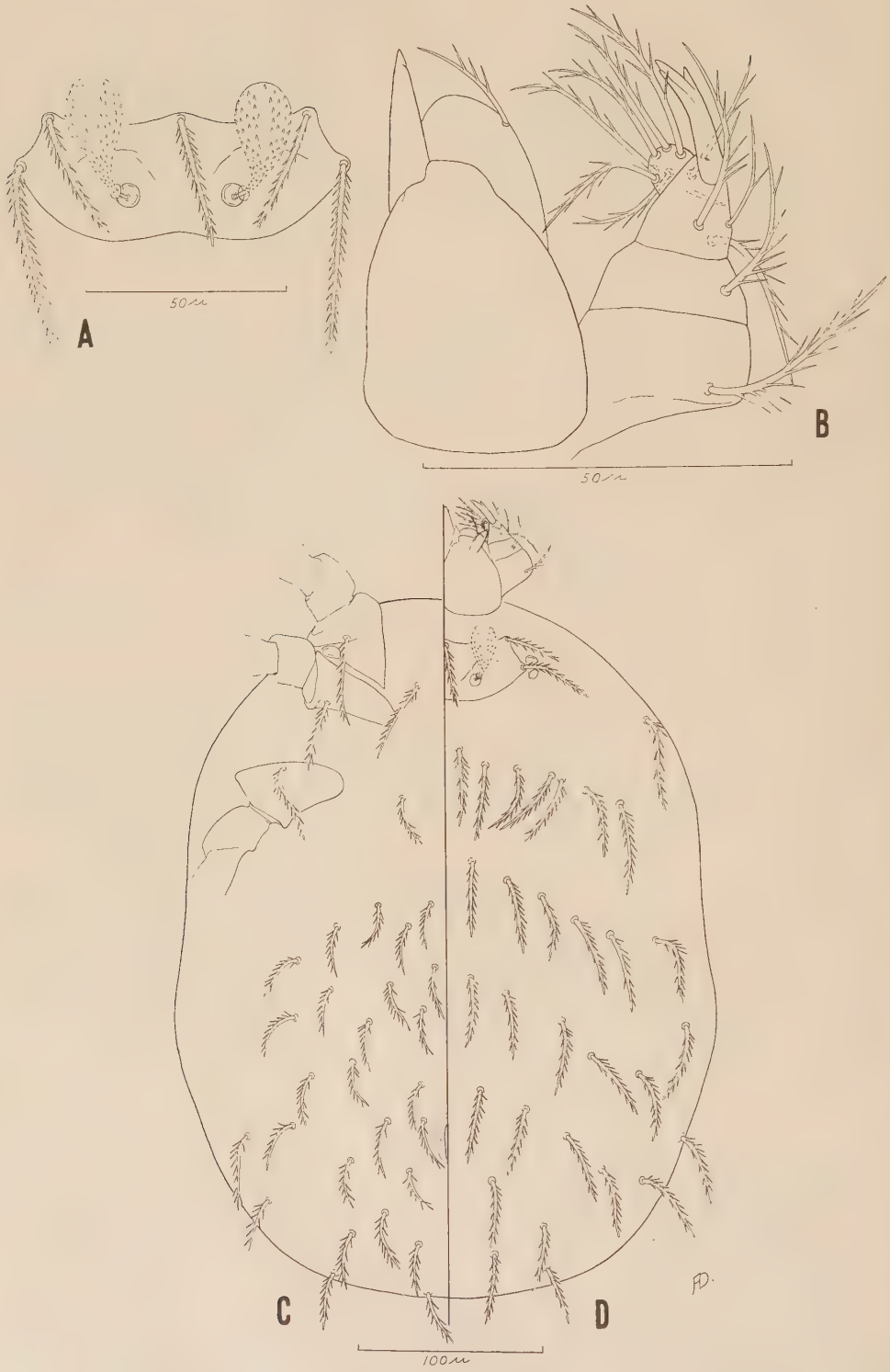


FIG. 6. *Euschöngastia criceticola* n. sp. A. Scutum. B. Dorsal view of capitulum. C. Venter. D. Dorsum.

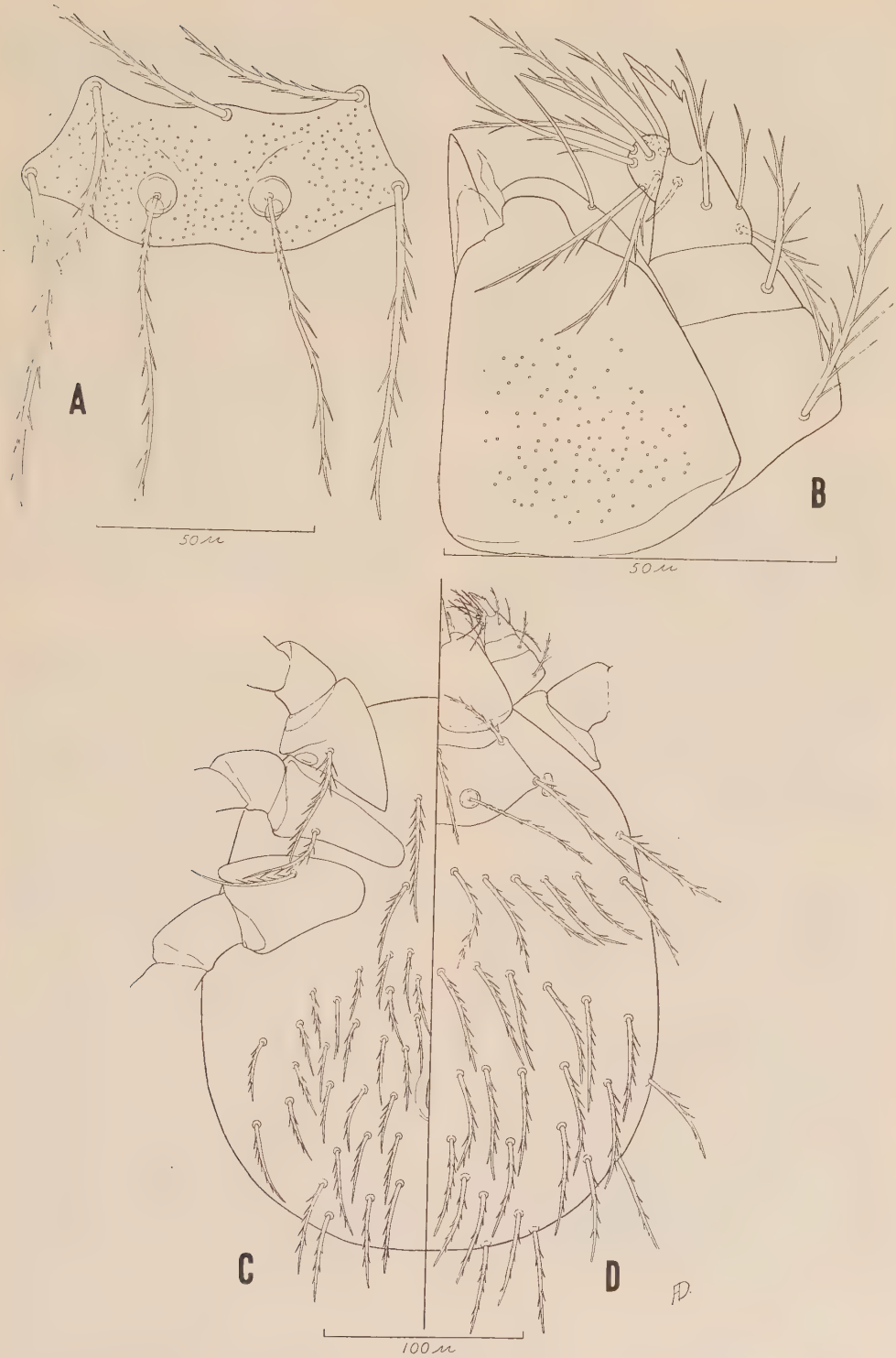


FIG. 7. *Trombicula jamesoni* n. sp. A. Scutum. B. Dorsal view of capitulum. C. Venter. D. Dorsum.

distance down the stem; basal half of stem bare. Sensillary bases separated by much more than the distance between anterolateral and posterolateral setae, and located posterior to a line between the posterolaterals; an irregular, inverted U-shaped, cuticular fold anterior to each sensillary base.

Standard measurements: Holotype: AW–60, PW–79, AP–15, SB–22, ASB–22, PSB–14, AM–34, AL–35, PL–49, S–37, DS–36 to 48. Average of eight paratypes: AW–61, PW–80, AP–17, SB–26, ASB–23, PSB–14, AM–33, AL–36, PL–48, S–35, DS–35 to 47.

Dorsum (Fig. 6, D): Eyes 2/2, no ocular plate. Dorsal formula variable, approximately 2–12–2–12–10–6–4–2; for the holotype, 2–14–2–12–10–8–4–2. The setae decrease in length from anterior to posterior rows.

Venter (Fig. 6, C): Two pairs of sternal setae, the anterior pair the longer. Ventral setae about 44, in irregular rows, those posterior to the anus largest.

Legs: Seven-segmented. Coxal setae, 1–1–1.

Type data: Holotype and two paratypes, larvae from *Peromyscus maniculatus artemisiae* (sagebrush white-footed mouse), Ravalli County, Montana, February 6, 1946, AP22130; five larvae, same host, Beaverhead County, Montana, September 3, 1945, AP21979; one larva from *Citellus lateralis tescorum* (Hollister mantled ground squirrel), Falls Creek, Elmore County, Idaho, June 26, 1945, AP21862. All collections by personnel of the Rocky Mountain Laboratory.

Holotype and four paratypes deposited in the collection of the Rocky Mountain Laboratory and three paratypes in the United States National Museum.

Euschöngastia criceticola appears to have affinities with *E. samboni* (Radford) from which it is distinguished by the branched galeal setae, impunctate cheliceral bases and scutum, and the considerably less depth of the scutum.

Trombicula jamesoni n. sp.
(Figs. 7 and 14)

Larvae, in life, pale yellow, broad-oval.

Size: Length, 215 to 625; width, 140 to 480.

Capitulum (Fig. 7, B): Chelicerae short, stout, with distinct subapical ventral tooth and smaller dorsal tooth. Base of chelicera subtriangular, little longer than wide, conspicuously punctate. Galeal seta nude. Palpal claw with five prongs; thumb with seven branched setae and a short spur; all palpal setae branched except the lateral seta on article 4 which is forked or sometimes simple.

Scutum (Figs. 7-A and 14): Scutum densely punctate; a little more than twice as wide as long; shaped as figured, the anterior and posterior margins approximating parallel reverse curves with the ends concave forward, lateral margins mildly incurved. Setae plumose, long, slender, of similar form; length of anterolaterals, anteromedian and posterolaterals increases in the order cited. Sensillae flagelliform, fairly thick, but thinner than the scutal setae; many short barbs on the basal quarter and about ten branches on the apical three-quarters. Sensillary bases separated by somewhat more than the distance between anterolateral and posterolateral setae and located slightly posterior to the posterolaterals; a diagonal cuticular fold in front of each base.

Standard measurements: Holotype: AW–60, PW–86, AP–24, SB–26, ASB–29, PSB–12, AM–52, AL–45, PL–80, S–76, DS–48. Average of ten specimens: AW–63, PW–89, AP–24, SB–28, ASB–27, PSB–12, AM–50, AL–44, PL–78, S–70 (average of four), DS–48.

Dorsum (Fig. 7, D): Eyes 2/2, sometimes almost contiguous, but not in an ocular plate. Dorsal formula, 2–12–12–10–6–2–4–2, a few extra setae sometimes interpolated. Setae of uniform size, their length not varying from anterior to posterior rows.

Venter (Fig. 7, C): Two pairs of sternal setae, the anterior pair the longer. Ventral setae more than 50, those in the four rows posterior to the anus are largest.

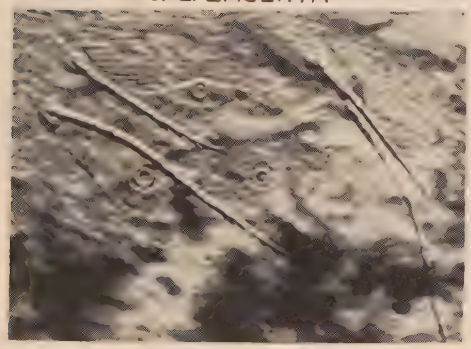
Legs: Seven-segmented. Coxal setae 1–1–1.

Type data: Holotype, larva from *Blarina brevicauda brevicauda* (short-tailed shrew), Tompkins County, New York, December 6, 1947, AP24589. Paratypes, three larvae, same data as holotype; seven larvae, same host and locality, May 24, June 7, July 12, and November 23, 1947, AP24602, AP24603, AP24610, and AP24439; eight larvae from *Sorex cinereus cinereus* (common shrew), Tompkins County, New York, December 6, 1947, AP24588; four larvae from *Sorex fumeus fumeus* (smoky shrew), same locality, June 7, 1947, AP24604. All collections by E. W. Jameson, Jr., Department of Zoology, Cornell University.

Holotype and twelve paratypes deposited in the collection of the Rocky Mountain Laboratory, six paratypes in the United States National Museum, two para-

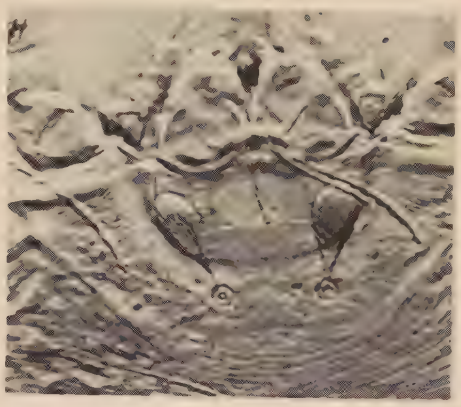
8. N. FULLBERGI

9. E. LACERTA

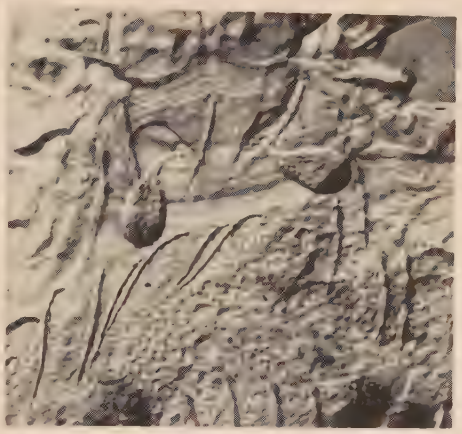


10. E. MIRICOXA

11. E. CORDIREMUS



12. E. LUTEODEMA



13 E. CRICETICOLA

14. T JAMESONI

FIGS. 8 to 14. Scutums of holotypes of new species of North American chiggers. Magnification 400×. (Photomicrographs with oblique illumination by N. J. Kramis, Staff Photographer, Rocky Mountain Laboratory.) Erratum: Fig. 8. For *fullbergi,* read *fullbergae.*

types in the British Museum (Natural History) and two paratypes in the South Australian Museum, Adelaide.

Trombicula jamesoni is not a typical representative of the genus to which it is tentatively assigned. In fact, in the absence of the flagelliform sensillae, the species could be placed with little hesitancy in the genus *Euschöngastia* by the shape of the scutum, the palpi angulate laterally and the five-pronged palpal claw. This unusual combination of generic characters and the apparent host preference for shrews should readily distinguish *jamesoni* from other North American species.

AMPHILINA BIPUNCTATA N. SP., A NORTH AMERICAN CESTODARIAN*

NATHAN W. RISER

A new species of the cestodarian genus *Amphilina* was found in a jar mislabeled "Trematoda" in the collection of the Hopkins Marine Station. Three complete and three damaged specimens were present. The label with the specimens bore the following information: "Dodson, Oregon. From coelom of sturgeon. Aug. 1923. Carl D. Duncan."

Amphilina bipunctata n. sp.

Specific diagnosis: Large representatives of the genus, reaching a length of greater than 50 mm. Broadly rounded posteriorly; conically pointed anteriorly. Apical organ small; lumen about 0.5 mm deep. 350–400 testes on each side between vitellaria and uterine coils, slightly overlapping the latter posteriad; not reaching posteriorly to ovary, nor anteriorly to end of vitellaria. Vasa efferentia anastomose in mid-line anteriad of ovary, thus producing a net prior to forming the vas deferens. Vas deferens much coiled, arising anteriad of ovary. Bulbus propulsorius pyriform, 0.97–1.05 mm long; maximum diameter through muscular portion 0.39–0.46 mm; maximum diameter including glandular layer 0.63–0.75 mm; distal portion crosses vagina dorsally. Ejaculatory duct dorsal and slightly lateral to vagina. Male pore terminal, in center of a papilla. Vitellaria lateral, consisting of tubular strands; divided into two portions on each side, a small anterior mass separated from the main mass. Ovary small, compact, with several finger-like lobes; in posterior 1/11th of body. Mehlis' gland well developed, attenuated posteriorly, 2–4 times as long as wide. Uterus arises dorsally from Mehlis' gland; primary ascending loop on opposite side of ovary from vas dèferens, internal to testicular field except posteriorly. Descending loop on same side, slanting to other side of ovary posteriad of testicular field, second ascending loop with massive transverse coils between the descending loop and testicular field; uterine pore terminal, adjacent to and ventrad of acetabulum. Seminal receptacle pyriform, 0.51–0.79 mm long by 0.36–0.45 mm maximum diameter. Anterior half of vagina spirals to seminal receptacle; posterior half straight. Vaginal pore in general body surface 0.04–0.07 mm lateral to male papilla. A lateral nerve trunk between vitellaria and testes on either side. Uterine ova oval, 0.112–0.150 mm long by 0.059–0.075 mm maximum diameter; shell 0.003 mm thick.

Type host: "Sturgeon."
Location: Coelom.
Type locality: Dodson, Oregon.
Type date: August, 1923.
Holotype: U.S.N.M. Helm. Coll. No. 46362.

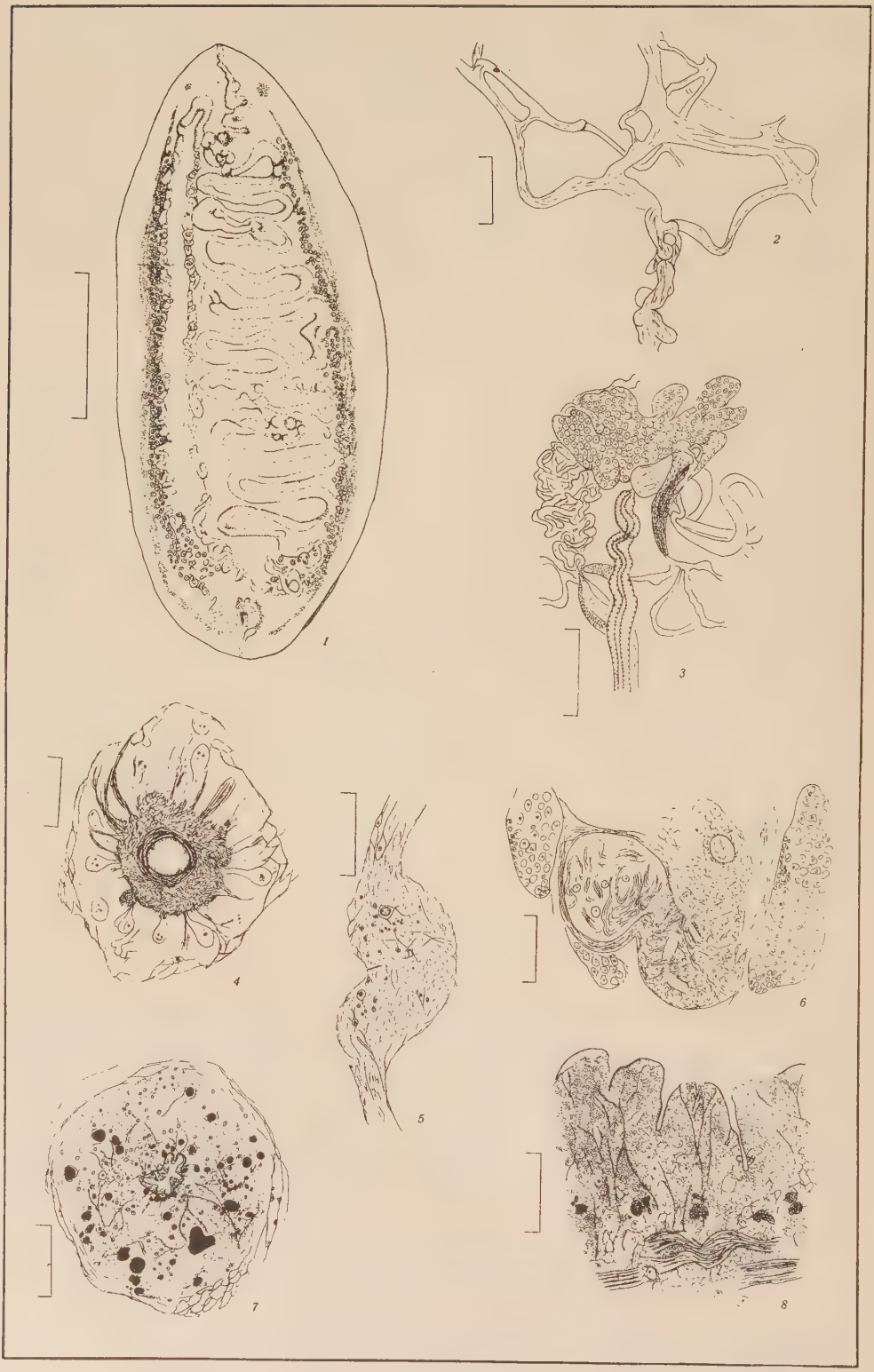
MORPHOLOGY

The species has the characteristic configuration of members of the genus, being dorsally convex and ventrally slightly concave except at the anterior end where both surfaces are convex. In surface view, the cuticle has a honeycomb-like appearance which seems to be characteristic of all of the Amphilinidae.

The holotype mounted in clarite measures 44 mm long by 20 mm maximum width. The corresponding measurements of the other two complete specimens measured in alcohol are 60 by 24, and 56 by 18. The maximum thickness is slightly over 3 mm.

The apical organ is quite small with a lumen 0.49–0.51 mm deep. It is longitudinally folded and in the anterior region, is 0.13–0.16 mm in transverse diameter

Received for publication, May 3, 1948.
* Contribution from the Hopkins Marine Station of Stanford University.



and 0.03 mm in dorso-ventral. Posteriorly, it is more or less star-shaped in cross-section (Fig. 7). It is lined with general body epithelium, the cuticular layer of which is very thin and covers a small layer of dense connective tissue. A heavy glandular layer is separated from the connective tissue by a ring of circular muscles. The glandular layer is 0.082–0.09 mm thick, producing an overall diameter of the organ of about 0.32 mm. All of this is enclosed in a loose connective tissue sheath 0.04 mm thick which extends slightly posteriad of the base of the pit, but does not cover the posterior gland cells. The glandular region consists primarily of unicellular glands, many of which are filled with secretion droplets (Fig. 7) which stain violet to maroon with Heidenhain's Azan stain. The apical organ of one sectioned specimen contained the secretion in the lumen. The gland cells do not extend posteriad of the anterior vitelline masses. Numerous small bundles of longitudinal muscle fibers extend from the region of the most anterior testes through the glandular region, dividing into fine branches most of which can be traced into the subcuticula of the acetabulum. The posterior glandular region of the organ is cut up by numerous dorso-ventral and diagonal muscle bundles. The organ is not an acetabulum or sucker under which terms it is usually designated in the literature. Woodland (1923) found this organ to be an eversible proboscis in *A. paragonopora* Woodland.* Poche (1925) referred to it as a "Rüssel" in *A. foliacea* (Rud.). The limited material of *A. bipunctata* did not show the organ as an eversible structure, and its true nature is not clear. It must be remembered that Lang (1881) interpreted the structure as an anterior gut rudiment. It will require the study of the life history and of living specimens to ascertain if this organ actually is comparable to a stomodaeum, or possibly even to the protrusible pharynx of the rhabdocoels.

The dermo-muscular sac (Fig. 8) is similar to that of *A. foliacea* as described by Salensky (1874). However, in *A. bipunctata,* the granular layer beneath the

* This species does not belong to the genus *Amphilina,* and Poche (1926) created the genus *Gephyrolina* to contain it. However, the three monotypic genera proposed by the latter author in the cited paper, differ markedly from the genus *Amphilina* and have much in common with one another. They have not been accepted generally and should be reexamined and properly assigned.

Explanation of Plate

All figures were made with the aid of a camera lucida except figure 1 which was drawn from a projection of the whole-mount. The scale for figure 1 equals 10 mm. The scale for figure 3 equals 1.0 mm; for figures 2 and 6 equals 0.20 mm; for figures 5, 7, and 8 equals 0.10 mm; and for figure 4 equals 0.05 mm.

Fig. 1. Dorsal view of holotype of *Amphilina bipunctata.*

Fig. 2. Anastomosing vasa efferentia uniting to form the vas deferens.

Fig. 3. Ventral view of the genital complex of the holotype. The ventral ovarian lobe which normally covers the anterior end of the Mehlis' gland is not known. The ducts are incompletely figured inside the Mehlis' gland.

Fig. 4. Transverse section of the anterior portion of the ejaculatory duct.

Fig. 5. Transverse section of one of the lateral nerve trunks showing dorsal and ventral nerves arising from ganglia on the outer side.

Fig. 6. Transverse section through the ovary, seminal receptacle and Mehlis' gland, showing the union of the ascending oviduct with the seminal duct. The uterus containing fragments of an egg lies dorsal in the Mehlis' gland.

Fig. 7. Transverse section through the base of the apical organ. The dark bodies are secretion droplets in the unicellular glands.

Fig. 8. Transverse section of the dermo-muscular sac.

circular muscles is not evenly distributed and the sub-cuticular glands are very scarce. The cuticle is so delicate that only traces remain in the present material. The longitudinal muscle layer is very well developed and consists of numerous small bundles of fibers. The circular muscle layer is composed of bundles of fibers which encircle the animal like barrel hoops. At the anterior and posterior ends of the body, they form arcs bowing toward the opposite extremity and lie 0.06–0.15 mm apart, converging at the margin. The dorso-ventral musculature is strongly developed. The fibers arise from cells in the sub-cuticula and are inserted for the most part in the external circular muscle bundles of the opposite side, though a few fibers pass between the circular bundles to insert into the longitudinal ones. An internal circular muscle layer is absent, its place being taken by scattered bundles of transverse fibers which occasionally course across the center of the parenchyma. Longitudinal and oblique bundles are scattered throughout the body internally to the external circular bands.

The nervous system even in the absence of sheaths is well defined because of the large size of the principal elements. The lateral trunks lie between the vitellaria and testes, and average between 0.075 and 0.09 mm in diameter. In the holotype, the trunks posterior of the testicular field lie amidst the vitelline strands on each side of the body. Dorsal and ventral nerves leave together at frequent intervals from ganglia on the outer side of the nerve trunks (Fig. 5). These are undoubtedly the nerves which Cohn (1904) described as connecting the nerve trunks dorsally and ventrally in *A. foliacea*. They are large nerves, 0.03 mm in diameter in *A. bipunctata,* but in spite of their size, they were not seen to connect the two trunks. They course 0.049 mm internal to the circular muscle layer sending fibers into the sub-cuticula. Since these nerves have held such a controversial position in the literature, it is regrettable that satisfactory material was not available for a more extensive study. Small bundles of fibers leave the main trunks as dorsal and ventral pairs reaching toward the margins of the body. Anteriad of the "brain," small bundles extend from the inner side of the trunks to the apical organ. The anterior commissure or "brain," is located some distance posterior to the apical organ just as Lang (1881) described it for *A. foliacea*. It occurs 3.07 mm from the anterior end in the holotype, and 3.00 mm in the sectioned specimen. It consists of fibers, small cell bodies, and a few ganglion cells. The posterior commissure agrees with that of *A. foliacea* as described and figured by Poche (1925). The lateral nerve trunks form ganglia from which fibers pass connecting the two. This commissure is ventral to the excretory bladder and immediately dorsal to the ejaculatory duct.

Cohn (1904) described an excretory vessel on either side of the body as well as other vessels scattered across his sections of *A. foliacea*. Hein (1904) described an excretory system consisting of a net-work emptying into four vessels which united to form a common vessel. The latter author's observations were made from living specimens of *A. foliacea* injected with Berlin blue, but his figure of the excretory system was made obviously from a contracted specimen, and thus the true nature of the lateral collectors was masked. The excretory net can be clearly seen in sections of *A. bipunctata,* but since the two dorsal and the two ventral collectors loop back and forth across the uterus in these contracted specimens, it has been

impossible to visualize the entire excretory system. To all appearances, it follows the general pattern of the genus as described by Hein (1904). The principal vessels lie internal to the vitellaria and nerve trunks. They average 0.06 mm in diameter, but diminish in size in the region of the ovary and appear briefly as small vessels running longitudinally into the prostate region. They could not be traced through the prostate region to the bladder. The latter structure is 0.43–0.49 mm long. The lumen is very small, about 0.023 mm in greatest diameter in the sectioned specimen. The walls stain a light pink with Heidenhain's Azan stain instead of blue as does the general body epithelium. The lumen wall is very thin, 0.006–0.013 mm. There is a thin sheet of connective tissue separating this from a large, poorly defined area of huge cells. The excretory pore is at the base of the male papilla along the side opposite the female opening. The latter lies some distance from the papilla. The ten embryonal hooks lie in the parenchyma surrounding the anterior end of the bladder.

The majority of the testes are irregular in shape, but many are oval, and a few are even round. They range in size from 0.24–0.52 mm in diameter. The testicular fields extend anteriad to almost 1.5 mm of the anterior ends of the main vitelline strands. The vasa efferentia are large and in the available material are filled with spermatozoa. These tubules anastomose frequently before leaving the testicular fields. Anterior to the ovary, the vasa efferentia from both sides fuse to form a mesh from which, by consolidation, the vas deferens leads off (Fig. 2). The vas deferens is a thin walled convoluted tubule over 2 mm long. The entire convoluted mass is surrounded by a matrix of densely packed fibers and minute cells set off from the parenchyma by a thin layer of fibromuscular tissue. It leads directly into the bulbus propulsorius. The lumen of the bulbus is lined with cells, the nature of which was obscured by coagulated secretion. A thick basement membrane lies beneath the cellular layer, and on the outer side of the membrane is a thick layer of circular muscles. A highly developed layer of unicellular glands lies outside the muscles. The tissues of the ejaculatory duct are a continuation of those of the bulbus. The principal changes take place in the glandular layer. In the proximal portion of the duct (Fig. 4), the circular muscle layer immediately diminishes in thickness. It is composed of two layers, the inner one being more compact. This may be the so-called penis reported by Salensky (1874) for *A. foliacea,* but it does not appear as a tube inside of a tube, and since Cohn (1904) and Hein (1904) could not demonstrate a protrusible organ in *A. foliacea,* and Johnston (1931) and Ihle and Ihle-Landenberg (1932) could not for *Austramphilina elongata* Johnston (= *Kosterina kuiperi* I. and I-L.) the occurrence of such an organ must still be questioned. Poche (1925, Fig. 20) figured a broken off penis in the vagina of *A. foliacea* and discussed the controversial issue. His figure and statements could as well apply to a bundle of sperm as to an intromittent organ. In the absence of sufficient material of *A. bipunctata* for sectioning, it is impossible to demonstrate conclusively the method of sperm transmission. The glandular region of the duct is about 1/6th of the thickness of that of the bulbus and in transverse sections consists of a single ring of cells separated from one another by fibromuscular tissue. The nuclei of the gland cells are arranged at the outer margin. This proximal portion which extends for about 12 per cent of the duct's length is

followed by the prostate region in which the outer connective tissue sheath is lost and the muscle layer is further reduced. The giant prostate cells fill the surrounding parenchyma. The lumen of the entire duct is lined with simple cuboidal epithelium. The distal portion of the duct is about 27 per cent of the duct's total length and consists of the cuboidal epithelial lining, the basement membrane, and a narrow band of muscles surrounded by dense connective tissue which blends rapidly into the parenchyma. The duct opens to the outside at the tip of a papilla which lies in a small pocket at the posterior end of the body.

The ovary in the holotype is 2.1 mm wide by 1.02 mm long. In two other mounts which contain the ovary, the respective measurements are 1.95 by 1.27 and 2.04 by 1.27. In transverse sections, it is shaped like a butterfly. The dorsal lobes are larger than are the ventral ones, and the isthmus is narrow and quite thin. The oviduct arises from a well defined oöcapt on the postero-ventral surface of the isthmus. The ring of unicellular glands surrounding the oöcapt is very strongly pronounced. The oviduct is a thick walled tube with a very small lumen. It extends posteriad for a short distance and then turns abruptly dorsad to unite with the duct from the seminal receptacle. This arrangement of the oviduct uniting with the seminal duct (Fig. 6) is noteworthy since the opposite condition of the seminal duct joining the oviduct is most frequently the case among the Cestoda *s. st.*

The vagina opens through a terminal pore in the ventral body surface opposite the side of the body in which the primary ascending loop of the uterus lies. The lumen of the vagina is lined with a ciliated epithelium in the anterior portion. The ciliated lining disappears posterior to the nerve commissure and the lumen is almost obliterated by heavy cuticular walls. A ring of muscles is present on the outer side of which lies a thick layer of cells of unknown function. The posterior portion of the vagina is straight and the anterior portion has a tendency to spiral. The vagina is separated from the seminal receptacle by a sphincter. The receptacle in the holotype is 0.76 mm long by 0.37 mm maximum diameter, and is more strongly attenuated at the end from which the seminal duct arises than it is in the other material. The seminal duct is met by the ascending oviduct almost immediately (Fig. 6). The fertilization passage thus formed drops ventrad and enters the Mehlis' gland. It continues posteriad for some distance and then abruptly swings dorsad and enlarges to form the oötype from which the uterus extends anteriad leaving the gland from the dorsal surface at about the level of the union of the seminal duct and oviduct. The Mehlis' gland is 1.78 mm long and 0.45 mm in diameter in the holotype. The long axis is in the sagittal plane.

The vitellaria are tubular in the available material. Possibly, younger specimens would show a follicular development. At the posterior end of the fields on either side, the strands are split so that two or more ducts can be seen. These ducts unite to form a single duct (Fig. 3) from either side posterior to the bulbus propulsorius. These ducts in turn fuse to form a common vitelline duct which extends anteriad along the dorsal surface of the Mehlis' gland. The duct turns abruptly ventrad to enter the oötype. The two small vitelline masses for which the species is named (Fig. 1) lie 0.52–0.88 mm anterior of the main masses, but the ducts from them could not be traced.

Poche (1925) found that the genitalia of *A. foliacea* could be described as either

right or left handed. The number of specimens with the primary uterine loop to the right was about the same as that of specimens with it to the left. In *A. bipunctata,* three of the specimens studied had the loop on the left, and one had it on the right. It is well known that in the genus, the primary ascending loop of the uterus is on one side of the body and the uterine pore, the vaginal pore, and the vas deferens are on the other side. These are generic characters and apply to *A. bipunctata.* The primary ascending and the descending loops are small in diameter when compared to the second ascending loop (Fig. 1).

RELATIONSHIPS

In *A. foliacea,* the vaginal pore is some distance lateral to the male papilla. The testes lie in the uterine field, and the vitelline masses are unbroken.

A. bipunctata is more closely allied to *A. japonica* Goto and Ishii, from which it differs in the size and shape of the testes and ova, the size of the apical organ, and the size of the bulbus propulsorius. The specific characters which differentiate the two species are that, in *A. japonica,* the bulbus propulsorius does not reach to the vagina; the testes extend to the anterior end of the vitellaria; the Mehlis' gland has a different configuration; and the vitellaria are unbroken. The authors of this species reversed the dorso-ventral orientation of their worm so that the uterine pore, vagina, Mehlis' gland, and ovarian isthmus were dorsal, and the ejaculatory duct and vas deferens were described as ventral in position.

REFERENCES

COHN, L. 1904 Zur Anatomie der *Amphilina foliacea* (Rud.). Ztschr. wissensch. Zool. **76**: 367–387.

GOTO, S. AND ISHII, N. 1936 On a new cestode species, *Amphilina japonica.* Japan. J. Exper. Med. Govt. Inst. Infect. Dis., Tokyo Imp. Univ. **14**: 81–83.

HEIN, W. 1904 Beiträge zur Kenntnis von *Amphilina foliacea.* Ztschr. wissensch. Zool. **76**: 400–438.

IHLE, J. E. AND IHLE-LANDENBERG, M. E. 1932 Uber einen neuen Cestodärier (*Kosterina kuiperi,* n.g. n.sp.) aus einer Schildkröte. Zool. Anz. **100**: 309–316.

JOHNSTON, T. H. 1931 An amphilinid cestode from an Australian tortoise. Austral. J. Exp. Biol. Med. Sc. Adelaide. **8**: 1–7.

LANG, A. 1881 Untersuchungen zur vergleichenden Anatomie und Histologie des Nervensystems der Platelminthen. III. Das Nervensystem der Cestoden im Allgemeinen und dasjenige der Tetrarhynchen im Besonderen. Mitth. Zool. Station Neapel. **2**: 372–400.

LYNCH, J. E. 1945 Redescription of the species of *Gyrocotyle* from the ratfish, *Hydrolagus colliei* (Lay and Bennet), with notes on the morphology and taxonomy of the genus. J. Parasitol. **31**: 418–446.

POCHE, F. 1925 Zur Kenntnis von *Amphilina foliacea.* Ztschr. wissensch. Zool. **125**: 585–619.

————1926 Das System der Platodaria. Arch. Naturgesch. Jahrg. **91**, Abt. A: 1–459.

SALENSKY, W. 1874 Ueber den Bau und Entwickelungsgeschichte der *Amphilina.* Ztschr. wissensch. Zool. **24**: 291–342.

WOODLAND, W. N. F. 1923 On *Amphilina paragonopora,* sp.n. and a hitherto undescribed phase in the life-history of the genus. Quart. J. Micr. Sc. **67**: 47–84.

EIMERIA AND *ISOSPORA* OF THE MINK (*MUSTELA VISON*)

NORMAN D. LEVINE

Department of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois, Urbana, Illinois

In December, 1946, the carcasses of two mink which had died suddenly were submitted by an Illinois mink ranch to the Veterinary Pathology Laboratory, University of Illinois, for diagnosis. Autopsies were performed by Dr. Paul D. Beamer, who found hemorrhagic gastro-enteritis in both animals. Bacteriologic cultures were negative. Post-mortem decomposition was so far advanced that sections made of the intestinal tract were unsatisfactory for histopathological study. Oöcysts of four species of coccidia were found in the intestinal tract of one mink, but none was found in the other. It is improbable that the coccidia were the cause of death of these animals.

Available information on the species of *Eimeria* described from the Mustelidae is collected in Table 1. Eight species have been named. *E. ictidea, furonis, mephitidis, mustelae* and *melis* are morphologically distinct. *E. vison, sibirica* and *irara* resemble *E. ictidea* morphologically, and it may be that future experimental cross-infection studies will reduce them to synonymy. In this connection, Kingscote (1934) reported experimental transmission of *E. vison* from the mink to the ferret. The form which Yakimoff and Gousseff (1936) described from the polecat as *E. mephitidis* certainly does not belong to that species. It lacks both micropyle and sporocyst residual body, and is more probably *E. mustelae*.

Available information on the species of *Isospora* reported from Mustelidae is given in Table 2. In a short article on mink parasites, Hansen (1933) stated that *I. bigemina* occurs in the mink and may cause heavy losses in the young. Sealander (1943), reporting a survey of helminth parasites of mink, mentioned in passing that *I. bigemina* was frequently noted in the feces. In addition, Railliet and Lucet (1891) mentioned a "*Coccidium bigeminum* var. *putorii*" in a paper on various coccidia, but did not state the host, which was presumably the ferret or polecat.

The *Isospora* described by Kotlán and Pospesch (1933) resembled *I. rivolta* more than *I. laidlawi*. Galli-Valerio's (1932) complete description of *I. mustelae* was: "Coccidies ovoïdes de $7 \times 2.25\ \mu$ à protoplasma en sphère de $1\ \mu$. L'extrémité à micropyle est légèrement aplatie. Deux sporoblastes de $6\ \mu$ avec reliquat de protoplasma, 4 sporozoïtes par sporoblaste." No figure was given. This description is sketchy, and a discrepancy between the dimensions stated for the oöcyst and sporoblasts should be noted. It does not correspond to either species of *Isospora* observed in the mink at this laboratory.

The coccidia encountered in the mink in the present study are described below:

Eimeria vison (Kingscote, 1934)
(Fig. 3)

Oöcyst dimensions ranged from 20 to $26\ \mu$ in length by 13 to $17\ \mu$ in width, with a mean of 22.8 by $15.4\ \mu$ and a mode of $22 \times 16\ \mu$ (based on measurements of 100 sporulated oöcysts). The length-width index ranged from 1.3 to 1.9, with a mean of 1.50 and a mode of 1.4. The lengths of these oocysts are shown graphically in Fig. 1, and their length-width ratios in Fig. 2.

Received for publication, May 3, 1948.

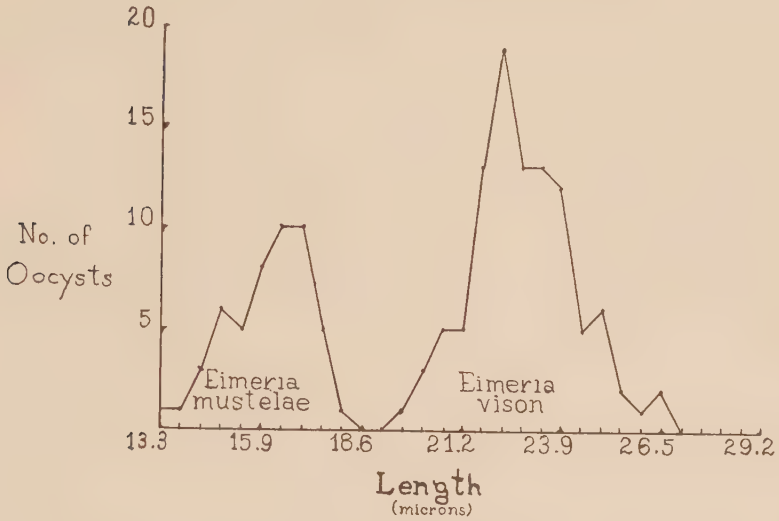


FIG. 1. Distribution of lengths of sporulated oöcysts of *Eimeria vison* and *E. mustelae* from the mink.

Thirty-two unsporulated oöcysts in smears direct from the intestinal tract measured 20 to 25 by 15 to 16 μ, with a mean of 22.9 by 15.4 μ and a mode of 23 by 15 μ. Their length-width ratios ranged from 1.3 to 1.7, with a mean of 1.51 and a mode of 1.5. The oöcysts were ellipsoidal in shape, with no perceptible micropyle. The oöcyst wall was composed of two layers, the outer layer colorless, and the inner layer pale salmon pink (this may possibly have been the result of staining by the hemolyzed blood in the intestine). No refractile granules were seen in the unsporulated oöcysts. Sporulation was complete 3 days after the oöcysts had been placed in a thin layer of 2.5% potassium bichromate in a Petri dish at room temperature. Four ellipsoid sporocysts, 11 by 8 μ, were present in each oöcyst. Each sporocyst contained two sporozoites, 9×3 μ. The sporozoites were broad at one end, tapering toward the other, the broad end of one being next to the small end of the other. A large, coarsely granular residual body was present in each sporocyst. After sporulation, from 1 to 4 or 5 refractile granules were seen in each

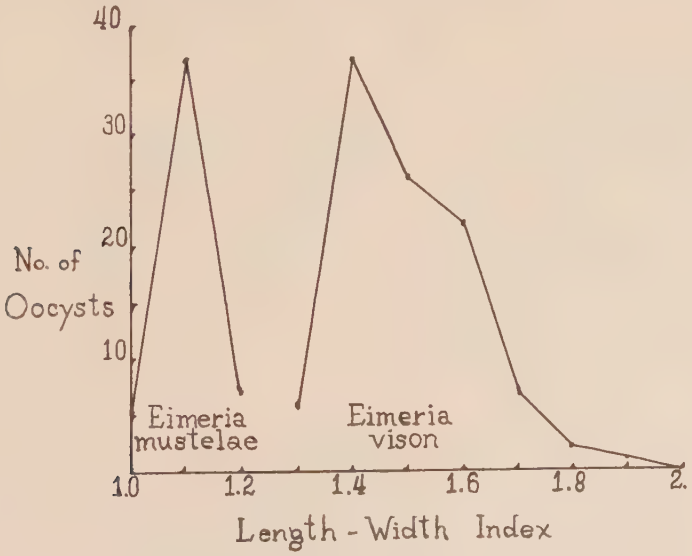


FIG. 2. Distribution of length-width ratios of sporulated oöcysts of *Eimeria vison* and *E. mustelae* from the mink.

oöcyst. These may have been residual to the formation of the sporocysts. A few oöcysts were found in the duodenum, but they were more abundant in the ileum and large intestine.

Kingscote (1934) stated that this species may cause a fatal disease of mink.

Eimeria mustelae Iwanoff-Gobzen, 1934
(Fig. 4)

Oöcyst dimensions ranged from 13 to 18 μ in length by 12 to 15 μ in width, with a mean of 16.1 by 14.4 μ and a mode of 16 by 15 μ (based on measurements of 50 sporulated oöcysts). The length-width index ranged from 1.0 to 1.2, with a mean of 1.10 and a mode of 1.1. The lengths of these oöcysts are shown graphically in Fig. 1, and their length-width ratios in Fig. 2. Eighteen unsporulated oöcysts in smears direct from the intestinal tract measured 15 to 17 by 14 to 15 μ, with a mean of 15.9 by 14.1 μ, and a mode of 16 by 14 to 15 μ. Their length-width ratios ranged from 1.0 to 1.3, with a mean of 1.14, and a mode of 1.2. The oöcysts were subspherical in shape, with no perceptible micropyle. The oöcyst wall was composed of two layers, the outer layer colorless and the inner layer pale salmon pink, but it is uncertain whether this color may have been the result of staining by the hemolyzed blood in the intestine. No refractile granules were seen in the unsporulated oöcysts. Sporulation was complete 3 days after the oöcysts had been placed in a thin layer of 2.5% potassium bichromate in a Petri dish at room temperature. Each oöcyst then contained four sporocysts, 8 by 5 μ, roughly ovoid, but with a constriction at one end. Two sporozoites, 7 by 3 μ, were present in each sporocyst. The sporozoites were broad at one end and tapering toward the other, the broad end of one lying next to the tapered end of the other. No true sporocyst residual body was seen, but it was probably represented by a small amount of scattered granular material in each sporocyst. After sporulation, from 1 to several refractile bodies were seen in each oöcyst; these may have been residual to sporocyst formation. A few oöcysts were found in the duodenum, but they were more abundant in the ileum and large intestine. The pathogenicity of this species remains to be determined.

Although it is somewhat smaller, this form resembles *E. mustelae* Iwanoff-Gobzen, 1934, from the snow weasel (Table 1) more than any other species described from the Mustelidae. However, spherical oöcysts were not seen, even those with a length-width ratio of 1.0 being slightly longer than broad. Since Iwanoff-Gobzen neither described nor figured sporulated oöcysts of *E. mustelae* except to state that no residual bodies were detected, no comparison of this stage can be made. Nevertheless it is considered best to assign the observed form to this species for the present.

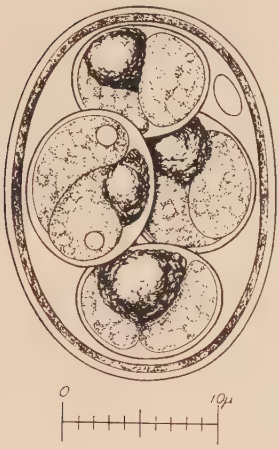
Isospora laidlawi Hoare, 1927
(Fig. 5)

A few oöcysts of this species were found in the intestinal contents of the mink upon examination after treatment with 2.5% potassium bichromate. Only five oöcysts were measured. Oöcyst dimensions ranged from 32 to 36 by 26 to 27 μ, with a mean of 34.0 by 26.5 μ. The length-width index ranged from 1.2 to 1.3, with a mean of 1.26. The oöcysts were ellipsoidal. The oöcyst wall was double, the outer wall being transparent, and the inner one pale yellowish. No micropyle and no oöcyst residual body were seen. Two ellipsoidal sporocysts were present in each oöcyst, each containing 4 sausage-shaped sporozoites, a small, granular residual body, and in some cases one or two spherical bodies which appeared to be oil droplets.

This form agrees very well with the description given by Hoare (1927) for *I. laidlawi* from the ferret. This is apparently the first record of its occurrence in the mink.

Isospora bigemina (Stiles, 1901)
(Fig. 6)

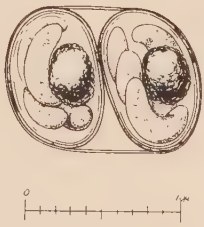
Oöcysts of this species were found in scrapings made from the duodenal mucosa of the mink, and both oöcysts and sporocysts were found in the intestinal contents. The oöcysts measured from 11 to 14 μ in length by 7 to 11 μ in width, with a mean of 12.4 by 9.0 μ. The length-width index ranged from 1.3 to 1.5, with a mean of 1.4. The oöcyst wall was composed of a single layer, and was so thin as to be almost invisible except under the oil immersion objective. It



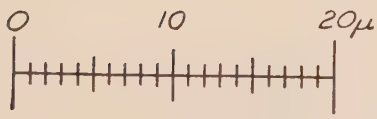
3.

4.

5.



6.



EXPLANATION OF PLATE

Fig. 3. Sporulated oöcyst of *Eimeria vison.*
Fig. 4. Sporulated oöcyst of *Eimeria mustelae.*
Fig. 5. Sporulated oöcyst of *Isospora laidlawi.*
Fig. 6. Sporulated oöcyst of *Isospora bigemina.*
All figures × 2000.

TABLE 1.—*Eimeria species described from Mustelidae*

Host	Eimeria species	Oöcyst shape	Oöcyst dimensions (microns)	Oöcyst L/W	Oöcyst micropyle	Residual bodies		Reference
						Oöcyst	Sporocyst	
Putorius putorius var *furo* (Ferret)	*ictidea*	Oval or elliptic	18–27 × 13–21 Mean 24 × 18	1.33	Sometimes	–	Large	Hoare, 1927
	furonis	More or less spherical	11–14 × 10–13 Mean 13 × 12-	1.08	–	–	Small	Hoare, 1927
Putorius putorius (Polecat)	*"mephitidis"**	Spherical	22–23	1.00	–	–	–	Yakimoff and Gousseff, 1936
Mustela vison (Mink)	*vison*	Oval or ovoid	17–22 × 9–18 Mean 20 × 15	1.33	–	In some	+	Kingscote, 1934, 1935
Mustela nivalis (Snow weasel)	*mustelae*	Spherical or suboval	Suboval 18–26 × 15–24 Mean 22 × 20 Spherical 18–26 Mean 20	Suboval 1.16 Spherical 1.00	–	–	–	Iwanoff-Gobzen, 1934
Martes zibelina (Siberian sable)	*sibirica*	Oval	21–28 × 17–21 Mean 24 × 19	1.25	–	–		Yakimoff and Terwinsky, 1931
	sibirica	Oval	20–25 × 16–18 Mean 22 × 18	1.20	–	–	+	Yakimoff and Gousseff, 1934
Martes martes (Marten)	*sibirica*	Oval	20–31 × 16–20 Mean 22 × 18	1.20	–	–	+	Yakimoff and Gousseff, 1934
Tayra barbara (Tayra)	*irara*	Oval	21–25 × 18–20	1.22	–	–	+	Carini and Fonseca, 1938
Meles taxus (Badger)	*melis*	Usually ovoid	17–24 × 13–17 Mean 21 × 15	1.40	–	–	Small	Kotlán and Pospesch, 1933
Mephitis (Skunk)	*mephitidis*	Broadly oval to spherical	17–25 × 16–22 Mean 21 × 19	1.08	+	–	Medium-sized	Andrews, 1928
Mephitis hudsonica (Skunk)	*mephitidis*	Round to oval	18–27 × 15–23 Mean 23 × 20	1.09	–	–	+	Yakimoff and Matikaschwili, 1932

* More probably *E. mustelae*.

TABLE 2.—*Isospora species described from Mustelidae*

Host	Isospora species	Oöcyst shape	Oöcyst dimensions (microns)	Oöcyst L/W	Oöcyst micropyle	Residual bodies		Reference
						Oöcyst	Sporocyst	
Putorius putorius var. *furo* (Ferret)	*laidlawi*	Ovoid	32–37 × 27–30 Mean 34 × 29	1.17	–	–	+	Hoare, 1927
Mustela vison (Mink)	*bigemina*	.....	.....	...	..	..	..	Hansen, 1933; Sealander, 1943
Martes martes (Marten)	*mustelae*	Ovoid	7 × 2.25	3.1	+	..	+	Galli-Valerio, 1932
Meles taxus (Badger)	*sp.* (resembling *I. rivolta*)	.....	26–34 × 19–27 Mean 29 × 23	1.26	–	–	+	Kotlán and Pospesch, 1933

appeared to be stretched by the sporocysts within it. There was no micropyle and no oöcyst residual body. The sporocysts measured approximately 11 by 7 μ, and each contained four sporozoites and a large residual body.

SUMMARY

Four species of coccidia, *Eimeria vison* (Kingscote, 1934), *E. mustelae* Iwanoff-Gobzen, 1934, *Isospora laidlawi* Hoare, 1927, and *I. bigemina* (Stiles, 1901), were found in a dead mink (*Mustela vison*) from an Illinois fur farm.

REFERENCES

ANDREWS, J. 1928 New species of coccidia from the skunk and prairie dog. J. Parasitol. **14**: 193–195.

CARINI, A. AND FONSECA, F. 1938 Sobre uma nova *Eimeria* (*E. irara* n. sp.) parasita da *Tayra barbara*. Arq. Biol. S. Paulo **22**: (n.p.).

GALLI-VALERIO, B. 1932 Notes de parasitologie et du technique parasitologique. Zbl. Bakt. I. Orig. **125**: 129–142.

HANSEN, K. B. 1933 Parasites of minks and their control. Amer. Fur Breeder **5**: 5–7.

HOARE, C. A. 1927 On the coccidia of the ferret. Ann. Trop. Med. and Parasitol. **21**: 313–320.

IWANOFF-GOBZEN, P. S. 1934 Sum Vorkommen von Coccidien bei kleinen wilden Saügetiere. Deut. Tierärztl. Woch. **1934**: 149.

KINGSCOTE, A. A. 1934 *Eimeria mustelae*, n. sp., from *Mustela vison*. J. Parasitol. **20**: 252–253.

————1935 A note on the coccidia of the mink. J. Parasitol. **21**: 126.

KOTLÁN, A. AND POSPESCH, L. 1933 Coccidial infections in the badger *Meles taxus* L. Parasitol. **25**: 102–107.

RAILLIET, A. AND LUCET, A. 1891 Note sur quelques espèces de coccidies encore peu étudiées. Bull. Soc. Zool France **16**: 246–250.

SEALANDER, J. A. 1943 Notes on some parasites of the mink in southern Michigan. J. Parasitol. **29**: 361–362.

YAKIMOFF, W. L. AND GOUSSEFF, W. F. 1934 Coccidia of martens and sables. J. Parasitol. **20**: 251–252.

———— AND ————1936 Kokzidiose des Iltis. Zbl. Bakt. I. Orig. **136**: 125–126.

———— AND MATIKASCHWILI, I. L. 1932 Coccidosis of skunks. Ann. Trop. Med. and Parasitol. **26**: 539–544.

———— AND TERWINSKY, S. K. 1931 Die Coccidiose des Zobeltieres. Arch. Protist. **73**: 56–59.

A TREMATODE PARASITE OF THE GENUS *CLINOSTOMUM* NEW TO THE SHAD, *ALOSA SAPIDISSIMA*

EDGAR H. HOLLIS
U. S. Fish and Wildlife Service, College Park, Maryland
AND
COIT M. COKER
Maryland Department of Research and Education, Solomons, Maryland

During the Fall of 1947 we tagged large numbers of fingerling shad for migration studies. Many of these specimens exhibited nodular protrusions of the skin which later were found to contain metacercariae of *Clinostomum marginatum* (Rudolphi, 1819).* Although this trematode is known to encyst as metacercariae in many species of fish (Hunter and Hunter, 1935), all previously reported fish hosts appear to be typical fresh-water forms. Shad are anadromous.

The young shad in which this parasite was observed were reared in fresh water ponds in two localities separated by several hundred miles. One pond, located near Fairlee, Maryland, is a spring-fed artificial impoundment having an area of 0.28 acres, receiving slight drainage from farmland on one side and woodland on the other. On May 21, it was heavily chlorinated to remove fauna likely to be predaceous on or competitors with young shad. At that time numerous mud-minnows, *Umbra pigmaea;* eels, *Anguilla rostrata;* several species of turtles, frogs, tadpoles, and salamanders were removed. On May 31, newly hatched shad fry were transferred to the treated pond. On November 7, when the pond was completely drained, twelve mud-minnows and one small eel were removed in addition to shad. These unwanted fish were probably introduced when an adjacent stream flooded into the pond at least once during the growing season. No other species of fish was present, though there were numerous tadpoles and frogs. No snails were observed.

The second pond in which parasitized shad were observed is located at the U. S. Fish and Wildlife Service hatchery near Westover, Virginia. This pond, 0.68 acres, receives its water from the artificially impounded Harrison Lake. It was sterilized with chlorine on April 15. Shad were stocked here as eggs on April 25, and seined out as fingerlings November 25 to 28. Gizzard shad, *Dorosoma cepedianum;* blue-spotted sunfish, *Enneacanthus gloriosus;* silvery minnows, *Hybognathus nuchalis;* frogs, tadpoles, and crayfish were found in small numbers in addition to shad. Some snails also were present.

The young pond-reared shad ranged in size from 67 to 88 mm. The parasitized shad had cysts measuring 1 by 2.5 to 3 mm, which were distributed at random on the body of the fish. None was seen in the region of the head. Some cysts, though covered by scales, appeared to be pigmented or more darkly colored than the surrounding tissue. On nicking a cyst with a sharp-pointed scalpel, the metacercaria, about 5 mm in length, was partially extruded, with one end apparently firmly attached to the inner flesh. Cysts located just under the skin of the live fish were

Received for publication, May 20, 1948.

* We thank Mr. Allen McIntosh, Bureau of Animal Industries, U. S. Department of Agriculture, Beltsville, Maryland, for the identification of this parasite.

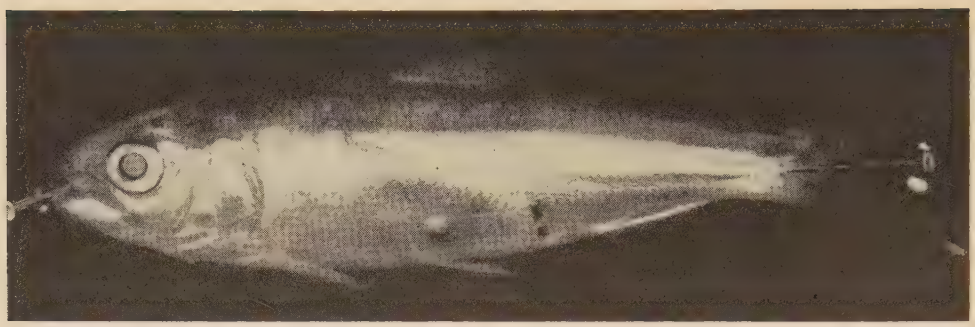
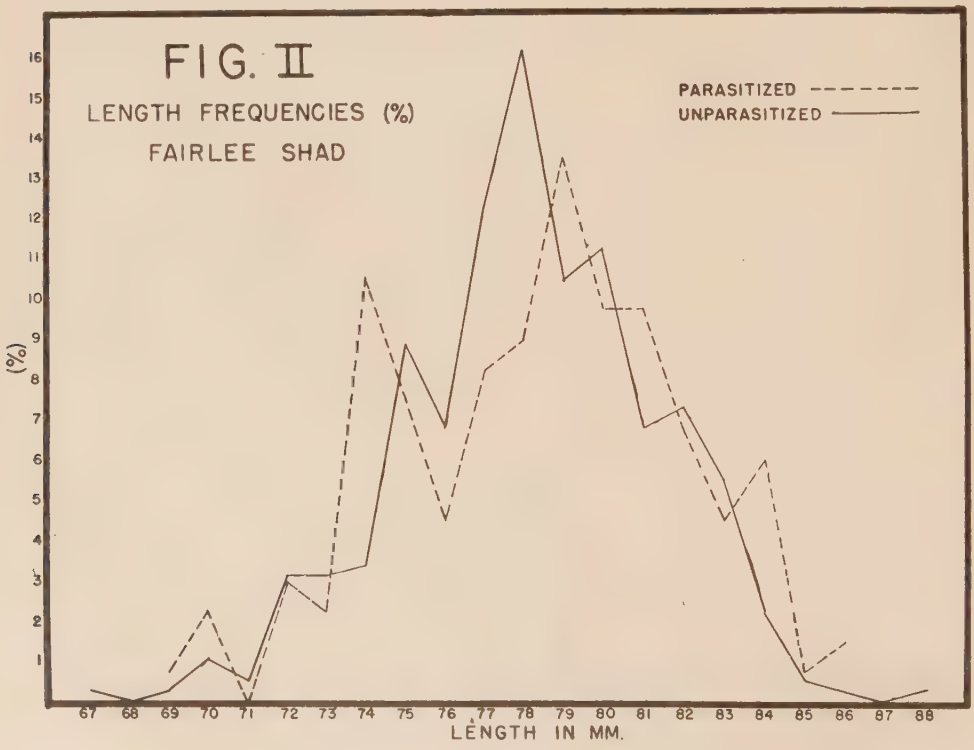


FIG. 1. Encysted *Clinostomum* is just above the ventral fin. The injury seen between the ventral and anal fins is an incision made for the insertion of a tag.

most apparent (Fig. 1); on the basis of these we estimated in the field that the incidence of infection at Fairlee was approximately 1 shad parasitized in 20, whereas at Harrison Lake only 3 shad in 1,500 were noted to be parasitized. Closer examination of specimens preserved from the Fairlee experiment proved these estimates to be too conservative, since some cysts were deeply imbedded and therefore not readily seen in the live fish.

A total of 519 shad collected at Fairlee were examined closely to determine the true incidence of infection. Of this number 134 (25.8 per cent) had cysts. A single cyst per fish occurred in 116 fish (22.4 per cent), 15 (2.9 per cent) had two cysts, and only 3 (0.6 per cent) had three cysts. No shad was observed to have more than three cysts.



Direct observations of the parasitized shad, tagged and held in tanks, indicated that they were as thrifty and active as the unparasitized fish. It is apparent from Fig. 2 that the level of parasitism encountered here has not materially altered the population in size composition; nor were the parasites selective for any particular size group. The mean length (measured to the fork of the tail) for the parasitized shad of 78.29 mm and the mean length of 78.15 mm for the unparasitized shad indicates that growth was not curtailed by this infection.

The difference in the observed incidence of parasites in fish from the two areas is of particular interest. Fish from the Harrison Lake pond were not examined in the laboratory, but the infection rate was certainly far lower than among those at Fairlee. There were, however, differing local conditions. Fairlee pond is secluded and seldom visited. Aquatic birds of many species frequent the area. The second pond is located at a hatchery and precautions are taken there to discourage fish-eating birds, which are the hosts for the adult fluke.

Although *Clinostomum marginatum* has not been reported previously from shad, it should be noted that these fish were not in a typical environment for the species. Though shad occur in fresh water, they are found in only those streams which have a free and unobstructed passage to the sea. Our fish were reared in ponds. We do not know whether this parasite infests shad under totally natural conditions.

Reference

Hunter, G. W., III and Hunter, Wanda S. 1935 Further studies on fish and bird parasites. Suppl. to 24th An. Rep. N. Y. State Conserv. Dept., 1934, No. IX, pp. 267–283.

OBSERVATIONS ON THE pH OF A CULTURE MEDIUM AND ON CULTURES OF *TRICHOMONAS FOETUS*

George E. Daniel[1]
Live Stock Sanitary Service, University of Maryland

An attempt to explain random variations in the hydrogen ion concentration of media used for the routine and experimental cultivation of *Trichomonas foetus* has lead to the experiments and observations reported in this paper.

CULTURE MEDIUM

A medium which does not require any blood serum has been used in this laboratory for several years. Directions for its preparation are as follows:

Beat eight eggs in 100 cc of saline (Rees, 1937) to which has been added one per cent of Lilly's liver extract No. 343. After mixing, tube in 2- to 3-cc amounts, slant and coagulate. Cover the coagulated slant with 8- to 10-cc of plain saline, stopper with cotton, and sterilize by autoclaving at 115 lbs for 15 to 20 minutes. No blood is used in the medium at any time.

Various concentrations of the liver extract were tried both in the egg and in the covering saline, and one per cent added to the egg gave as good or better results than other combinations. The trichomonads may live in this medium for as long as 30 days at incubator temperature. The life expectancy of a given culture is not as long as that reported by Schneider (1942) for his medium, but the liver extract mixture would seem to have certain other advantages. Routine transfers are made at 10- to 14-day intervals. The liquid portion of the medium is clear, there is little or no sediment, and the egg slant does not disintegrate on long standing. Clouding of the saline indicates most types of bacterial contamination. Isolations have been made from several cases of trichomoniasis and several different strains of trichomonads have been transferred from other media to the one here described. The new medium will support the growth of the protozoan in the absence of all bacteria.

This medium was used throughout these experiments with only such variations as were required to determine the points at issue in the particular experiments. In the following discussion it is referred to as the standard medium.

METHOD FOR MEASURING pH

The Beckman Model G pH meter with Beckman glass electrode for use outside of the shielded compartment and a specially designed calomel cell and sample cup were used for the measurements.

Both cell components and tubes to be measured were always kept in a constant temperature box and all measurements, unless specifically indicated otherwise, were made at a temperature of 35° ± 1° C. The glass electrode was suspended in a heavy bakelite block which in turn was carried on an iron support fixed to the bottom

Received for publication, May 20, 1948.

[1] Present address: Laboratory of Physical Biology, National Institute of Health, U. S. Public Health Service, Bethesda 14, Maryland.

of the incubator. This support also carried the calomel half cell and the sample cup. The holder for the sample cup was adjustable, and suitabe stops were used so that the glass and calomel electrodes were immersed to a constant depth in the test solution. The quantity of sample, approximately 5 cc, was such as to cover completely the active portion of the glass electrode.

Between each reading the electrodes and sample cup were rinsed with distilled water at the temperature of the incubator and the excess water removed with soft paper. If at any time it was necessary to turn off the heaters or remove the electrodes from the constant temperature box, a minimum of four hours was allowed for all components to reach temperature equilibrium before further measurements were made.

The section of the box containing the electrodes was shielded with copper screen. The leads from both half cells were carried through the sides of the box in glass tubing and further shielded by means of copper screen sleeves. The position of the indicating instrument and the external support of the electrode leads were so arranged that the sleeve did not touch either the table top nor the instrument case, although the sleeves extended into the shielded compartment. These various shielded areas were electrically integral and were grounded to a water pipe. All connections were securely soldered. Such shielding may seem superfluous; but until it was put in, there were days when it was impossible to secure uniform and steady readings on the instrument.

Before being used the first time, the glass electrode was soaked in distilled water for twenty-four hours and between runs the active portion of the electrode was kept immersed in distilled water. When not in use, the calomel cell was protected with a rubber sleeve. Care was exercised to see that no crystals of KCl formed in any portion of the cell.

An acid buffer was prepared from U. S. Bureau of Standards potassium acid phthalate according to directions furnished with the salt. Alkaline buffer was prepared from sodium borate and was made according to directions given by Dole (1941). The pH of the phthalate was accepted as 4.02 and of the borate as 9.07. Phthalate at 35° C was used as standard to calibrate the meter before each series of determinations. If there was any discrepancy in the reading of the borate buffer following such calibration, no readings were taken until the reason for the trouble had been located and corrected. At the end of each series of measurements, the meter was again checked with the two buffers and if the drift was more than $\pm$ 0.01 unit, the entire series was discarded and another experiment run.

The reading of the second decimal on the Beckman pH meter scale may well be questioned. It is probable that the instrument is sensitive to changes of this magnitude but the reproducibility of such close estimates by the observer is doubtful. In the work here reported where a well buffered solution was being measured, where careful shielding and temperature control was in effect, where rigid stability of the measuring system was demanded before any measurements were accepted, and where standardizing buffers at both acid and alkali ends of the scale were used, it is felt that there can be no question of the validity of the results to 0.1 pH unit and that the second decimal may be considered as indicating further the shift or stability of the measurements.

EXPERIMENTAL

Throughout these experiments the egg for slants was always mixed in saline which contained one per cent liver extract. Two measurements were made on the saline of each tube; approximately one-half was poured into the sample cup, measured and discarded. A second and equal portion was then poured from the culture tube, measured and discarded. In the tables and discussion the first portion is designated "top" and the second, "bottom." In preliminary experiments as many as three portions of saline from the same tube have been measured. These showed small but definite differences in pH between the various portions. In earlier experiments, samples removed with a pipette showed no appreciable difference from those poured from the tube. Apparently any disturbance of CO_2 equilibrium or other factors affecting the pH were about equal in the two methods. Since pouring was less cumbersome, this was adopted as standard procedure.

In each experiment a sufficiently large number of tubes was prepared at one time to conduct the entire experiment. In the case of inoculated tubes the pH at time of inoculation was considered to be equal to that of identical tubes which were measured on the same day that the inoculations were made. It would be very desirable if the culture tubes and electrodes were so designed that continuous or at least very frequent pH readings could be made on a culture throughout its entire life.

Experiment 1

Egg mixture and saline were made as for the standard medium. The egg was tubed in 2-cc amounts. Saline was adjusted to pH 3.40 with racemic lactic acid and the slants covered with 10-cc portions of the acidified saline. The pH was measured on groups of twenty tubes immediately after cooling to incubator temperature, 48 hours, 96 hours, and two weeks after preparation, respectively. One group of tubes was well shaken 48 hours after preparation and the pH measured 48 hours subsequent to the mixing. All of the tubes were kept in the culture incubator until measured. Results, except those on the shaken tubes, are shown in Table 1. The readings on these tubes were intermediate between the 48-hour and the 96-hour

TABLE 1.—*The pH of standard egg slants covered with saline adjusted to pH 3.40 with racemic lactic acid*

Tube no.	Immediately after cooling			48 hours after preparation			96 hours after preparation			2 weeks after preparation		
	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference
1	4.80	5.10	0.30	5.09	6.02	0.96	5.30	6.10	0.80	5.89	6.11	0.22
2	4.59	5.00	0.41	5.04	5.99	0.95	5.79	6.10	0.31	5.67	6.03	0.36
3	4.66	4.81	0.15	5.05	6.20	1.15	5.83	6.19	0.36	5.78	6.04	0.26
4	4.50	4.80	0.30	5.49	6.09	0.65	5.50	6.19	0.69	5.91	6.11	0.20
5	4.55	4.90	0.35	4.78	6.04	1.26	5.51	6.15	0.64	5.82	6.14	0.32
6	4.58	4.86	0.28	4.70	5.95	1.25	5.28	6.25	0.97	5.92	6.12	0.20
7	4.48	4.90	0.42	5.03	6.09	1.06	5.14	6.26	1.02	5.79	6.12	0.33
8	4.41	4.61	0.20	5.28	6.23	0.95	5.51	6.19	0.68	5.91	6.12	0.21
9	4.51	5.00	0.40	5.13	6.15	1.02	5.64	6.10	0.46	5.89	6.10	0.21
10	4.61	5.01	0.40	5.17	6.21	1.04	5.80	6.30	0.50	5.81	6.02	0.21
11	4.46	4.70	0.24	5.41	...	...	5.27	6.12	0.85	5.85	6.10	0.25
12	4.65	4.94	0.29	5.04	6.20	1.16	5.79	6.29	0.50	5.94	6.12	0.18
13	4.70	5.20	0.50	5.40	6.21	0.81	5.80	6.19	0.39	5.90	6.19	0.29
14	4.70	5.36	0.66	5.48	6.25	0.77	5.78	6.17	0.39	5.82	6.12	0.30
15	4.55	4.85	0.30	4.98	6.09	1.11	5.78	6.29	0.51	5.89	6.18	0.29
16	4.50	4.99	0.49	5.29	6.29	1.00	5.81	6.20	0.40	5.93	6.16	0.13
17	4.71	5.10	0.39	5.35	6.15	0.80	5.55	6.19	0.64	6.01	6.20	0.19
18	4.59	5.12	0.53	5.11	6.15	1.04	5.29	6.28	0.99	5.99	6.19	0.20
19	4.60	4.98	0.38	5.10	6.20	1.10	5.49	6.21	0.72	5.79	6.00	0.21
20	4.55	...	...	5.11	6.28	1.17	5.50	6.36	0.86	5.71	6.01	0.30

unshaken tubes. This was in line with previous observations on the stratification of pH, and it does not seem necessary to record the actual figures.

Experiment 2

Standard saline was brought to pH 3.38 with racemic lactic acid and eight eggs were well mixed in 100 cc of this saline. The egg was tubed in 2-cc amounts and the covering saline in 10-cc amounts. One hundred tubes were prepared and measured as described in Experiment 1. The results are recorded in Table 2.

TABLE 2.—*The pH of culture medium when both the egg slant and the covering saline is adjusted to pH 3.38 with racemic lactic acid*

Tube no.	Immediately after preparation			48 hours after preparation			96 hours after preparation			2 weeks after preparation		
	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference
1	4.80	5.09	0.29	5.46	5.96	0.50	5.40	6.22	0.82	6.31	6.29	0.02
2	4.48	5.10	0.62	4.97	6.05	1.08	5.70	6.20	0.50	6.30	6.31	0.01
3	5.14	5.40	0.26	5.33	6.02	0.69	5.35	6.00	0.65	6.29	6.29	0.00
4	4.71	...	...	5.55	6.20	0.65	5.82	6.26	0.44	5.90	6.20	0.30
5	4.62	5.00	0.38	4.89	5.63	0.74	5.89	6.15	0.26	5.95	6.18	0.23
6	4.90	...	...	5.39	6.01	0.62	5.65	6.29	0.64	6.32	6.32	0.00
7	5.09	5.52	0.43	5.30	6.12	0.82	5.89	6.27	0.38	6.31	6.31	0.00
8	4.79	5.03	0.24	5.48	6.35	0.87	5.60	6.30	0.70	6.29	6.29	0.00
9	4.94	5.22	0.28	5.38	6.23	0.85	5.72	6.21	0.49	6.19	6.22	0.03
10	4.36	5.11	0.25	5.10	5.20	0.10	6.05	6.29	0.14	6.30	6.30	0.00
11	4.52	4.97	0.35	5.33	6.05	0.72	5.31	6.28	0.97	6.30	6.30	0.00
12	4.85	5.20	0.35	5.39	6.34	0.95	5.90	6.28	0.38	6.25	6.27	0.02
13	4.65	4.96	0.31	5.19	5.96	0.77	5.90	6.25	0.35	6.31	6.31	0.00
14	4.91	5.32	0.41	5.31	6.15	0.84	5.64	6.01	0.37	6.00	6.25	0.25
15	4.87	5.27	0.40	4.78	4.37	0.59	5.80	6.29	0.49	6.27	6.28	0.01
16	4.78	5.65	0.87	5.24	6.36	1.12	5.39	6.10	0.71	6.00	6.19	0.19
17	4.99	5.31	0.32	4.86	5.40	0.54	5.98	6.19	0.21	6.24	6.25	0.01
18	4.50	4.85	0.35	5.27	6.14	0.87	5.29	6.21	0.92	6.28	6.28	0.00
19	4.94	5.55	0.61	5.50	6.21	0.71	5.41	6.26	0.85	6.20	6.23	0.03
20	4.53	4.92	0.39	5.00	5.47	0.47	5.18	6.18	1.00	6.31	6.31	0.00

Experiment 3

Standard egg in 2-cc amounts was slanted and covered with 10 cc of standard saline brought to pH 3.35 with HCl. Batches of 10 tubes were measured immediately after cooling to incubator temperature, at intervals of 24, 48, and 96 hours and two weeks after preparation, respectively. Results are shown in Table 3.

Experiment 4

Standard saline was brought to pH 3.42 with HCl. The eggs were mixed in this saline and the slant covered with 10-cc portions of the acidified saline. The pH of batches of 10 tubes was measured immediately after cooling and at intervals of 24, 48, 96 hours and two weeks after preparation respectively. Results are shown in Table 4.

Experiment 5

Standard egg mixture was prepared and the mixture then brought to pH 4.00 with HCl. Egg was tubed in 2-cc amounts and the slant covered with 10 cc of standard saline brought to pH 4.00 with HCl. Unlike the tubes in all previous experiments, a portion of these tubes was inoculated with trichomonads from four-day-old stock cultures. Several stock cultures were pooled and equal amounts of the inoculum, taken from the pooled sample, were added to each of the experimental tubes. The tubes were inoculated four days after preparation. Results of this experiment are given in the next section.

TABLE 3.—*The pH of medium when standard egg slants are covered with saline adjusted to pH 3.35 with hydrochloric acid*

Tube no.	Immediately after preparation			24 hours after preparation			48 hours after preparation			96 hours after preparation			2 weeks after preparation		
	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference
1	7.58	7.43	0.15	7.41	7.40	0.01	7.32	7.31	0.00	7.32	7.32	0.00	7.21	7.19	0.02
2	7.60	7.50	0.10	7.48	7.38	0.10	7.36	7.36	0.00	7.32	7.31	0.01	7.18	7.18	0.00
3	7.74	7.58	0.16	7.41	7.39	0.02	7.36	7.33	0.03	7.31	7.31	0.00	7.19	7.19	0.00
4	7.58	7.40	0.18	7.40	7.40	0.00	7.42	7.31	0.11	7.31	7.30	0.01	7.18	7.18	0.00
5	7.65	7.50	0.15	7.44	7.40	0.04	7.38	7.36	0.02	7.44	7.30	0.10	7.18	7.18	0.00
6	7.72	7.50	0.22	7.39	7.38	0.01	7.45	7.33	0.12	7.33	7.31	0.02	7.21	7.20	0.01
7	7.72	7.54	0.18	7.41	7.35	0.06	7.36	7.34	0.02	7.38	7.49	0.09	7.18	7.18	0.00
8	7.71	7.50	0.21	7.46	7.30	0.16	7.39	7.37	0.02	7.31	7.31	0.00	7.18	7.18	0.00
9	7.55	7.41	0.14	7.38	7.36	0.02	7.41	7.34	0.07	7.39	7.35	0.04	7.19	7.19	0.00
10	7.67	7.54	0.13	7.40	7.40	0.00	7.41	7.33	0.08	7.30	7.30	0.00	7.19	7.20	0.01

TABLE 4.—*The pH of culture medium when both the egg slant and the covering saline are adjusted to pH 3.42 with hydrochloric acid*

Tube no.	Immediately after preparation			24 hours after preparation			48 hours after preparation			96 hours after preparation			2 weeks after preparation		
	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference	Top	Bottom	Difference
1	7.36	7.31	0.05	7.28	7.25	0.03	7.38	7.28	0.10	7.24	7.23	0.01	7.11	7.11	0.00
2	7.15	7.14	0.01	7.23	7.28	0.05	7.28	7.24	0.04	7.22	7.21	0.01	7.15	7.15	0.00
3	7.39	7.32	0.07	7.25	7.25	0.00	7.25	7.23	0.02	7.19	7.20	0.01	7.23	7.22	0.01
4	7.39	7.34	0.05	7.30	7.25	0 05	7.20	7.24	0.04	7.20	7.20	0.00	7.14	7.11	0.03
5	7.49	7.42	0.07	7.26	7.27	0.01	7.26	7.23	0.03	7.22	7.20	0.02	7.11	7.11	0.00
6	7.40	7.31	0.09	7.27	7.23	0.04	7.27	7.25	0.02	7.24	7.21	0.03	7.11	7.09	0.02
7	7.36	7.29	0.07	7.28	7.28	0.00	7.28	7.25	0.03	7.25	7.21	0.04	7.11	7.10	0.01
8	7.34	7.29	0.05	7.28	7.22	0.06	7.27	7.29	0.02	7.21	7.20	0.01	7.10	7.09	0.01
9	6.91	7.00	0.09	7.23	7.21	0.02	7.25	7.28	0.03	7.22	7.21	0.01	7.10	7.10	0.00
10	...	...	...	7.27	7.23	0.04	7.30	7.26	0.04	7.25	7.21	0.04	7.10	7.09	0.01

Experiment 6

The same as Experiment 5, except the egg and saline were brought to pH 3.51 with HCl. Results are given in the next section.

Experiment 7

Standard egg mixture was brought to pH 4.01 with racemic lactic acid, tubed in 2 cc amounts, and covered with standard saline brought to pH 4.01 with racemic lactic acid. Ten cc of saline was used as covering. The tubes were inoculated as in Experiment 5. Results are given in the next section.

Experiment 8

The same as Experiment 7, except the egg mixture and saline were brought to pH 3.51. Results are given under the next section.

Experiment 9

A portion of the egg mixture used in Experiment 6 was brought from pH 3.51 to pH 7.20 with NaOH. This shift in pH produced a very large amount of precipitate which was filtered off with cheesecloth. The filtrate was tubed in 2-cc amounts and slanted. The slants were covered with saline brought to pH 7.20. The autoclaved tubes were kept in the incubator and a portion inoculated with trichomonads five days after preparation. Inoculum was from the same source as that used in Experiments 5, 6, 7, and 8. Results of this experiment are given in the next section.

RESULTS

The figures presented in Tables 1 and 2 show quite definitely that there is a wide variation in the pH of the medium before and after autoclaving. This variation holds when the group is considered as a unit and when individual tubes are compared. The pH continues to shift for a period of at least two weeks. The variation of the pH from top to bottom of the covering saline is very marked. The variations noted above are seen in both Experiments 1 and 2, but are greater in Experiment 1 than in 2. After two weeks the pH of tubes in Experiment 2 is practically constant in different portions of the covering saline, but is widely different from the values found before and just after autoclaving.

Experiments 3 and 4 (Tables 3 and 4) are similar in design to 1 and 2, except that HCl was used instead of racemic lactic acid. When HCl is used as the adjusting agent, the change after autoclaving is much greater than when the lactic acid is used. While there is variation from top to bottom in the fluid, these changes are not as great as in the lactic acid experiments. Equilibrium is reached in 48 to 96 hours, although at the latter time an occasional tube is found in which the variation top to bottom is 0.10 pH unit. The pH of the HCl tubes after autoclaving is similar to that of standard tubes. There is, however, one significant difference in them. Standard cultures, containing unmeasured amounts of both egg and saline may not reach pH equilibrium from top to bottom for at least 13 days after preparation. Differences from top to bottom as small as 0.05 and as large as 0.25 pH units have been observed.

There has been an almost complete reversal in the relationship between the pH of the top and bottom portions of saline in Experiments 1 and 2 and Experiments

3 and 4. In the first two the top is consistently more acid than the bottom, while in 3 and 4 this relationship is reversed.

After autoclaving, the tubes of Experiment 5 showed a pH at the top of 4.28 to 4.29 and at the bottom, 4.29 to 4.30. The initial pH of both the saline and egg before autoclaving was 4.00. Five days after autoclaving the top (uninoculated tubes) was 4.28 to 4.29. The bottom portion gave the same readings. There was no variation in excess of 0.02 pH in any individual tube .

Tubes in Experiment 6 showed almost the same behavior as those in Experiment 5, except that the pH after autoclaving was top 3.72 to 3.74 and bottom, 3.75 to 3.77, the initial pH of egg and saline being 3.51. The pH shift in both Experiments 5 and 6, apparently due to autoclaving, is about the same magnitude as seen in most bacteriological media but in the opposite direction. It is to be noted that the pH shift occurred during or immediately after autoclaving and that equilibrium was established by the time the tubes had reached the temperature of the electrode box. This rapid equilibration is in sharp contrast to the progressive changes noted in the preceding experiments.

In Experiment 7 the egg and saline was brought to pH 4.01 before autoclaving. Immediately after autoclaving and cooling, the pH was 4.06 to 4.08 on top and a a constant 4.08 on the bottom. Measurements on companion tubes five days after autoclaving gave uniform values of 4.08 for both top and bottom portions.

Tubes of Experiment 8, initial pH 3.51, shifted after autoclaving to pH 3.61 at both top and bottom. Six days after autoclaving, the same values were obtained on comparable tubes. In this series the shift following autoclaving was 0.10 pH. In another similar series the shift was only 0.04 to 0.06 pH units.

When the egg and saline are acidified with lactic acid, the shift following autoclaving is smaller than when HCl is used to adjust the hydrogen ion concentration. This seems to be true, also, for those tubes of Experiments 1 to 4 inclusive. In the latter experiments the variations and shifts in pH are so great as to make comparisons unreliable.

Four days after autoclaving the tubes of Experiment 9, which had been kept at incubator temperature since preparation, showed a range on top of 7.48 to 7.51 and at the bottom, 7.35 to 7.40. The range of difference, top to bottom, in individual tubes was 0.09 to 0.14 pH. Thirteen days after preparation the pH of top was 7.21 to 7.26 and at the bottom, 7.19 to 7.22, with a difference, top to bottom, in individual tubes ranging from 0.02 to 0.6 pH unit. In this series autoclaving produced an immediate shift of approximately 0.30 pH. It is not known whether there was any greater difference than this, but by the thirteenth day the tubes had returned to essentially the pre-autoclaving pH value.

The discussion given above deals exclusively with the findings in uninoculated tubes. A portion of the tubes in Experiments 5 to 9, inclusive, were inoculated with *Trichomonas foetus,* as indicated in the section on experimental procedure. All cultures were free of bacteria. In the following paragraphs the findings and observations on the inoculated tubes are given.

Four days after preparation, ten tubes of Experiment 5 were inoculated. The pH of the top was 4.28 to 4.29 and that of the bottom was 4.29 to 4.30. Three cultures were dead 24 hours later, and the remaining seven, 48 hours after inoculation. The pH of the negative tubes was top 4.29 to 4.30, bottom 4.28 to 4.32. The range of difference, top to bottom, in any one tube was 0.00 to 0.02.

In Experiment 6, ten tubes were inoculated at pH range of top 3.72 to 3.74, and bottom 3.75 to 3.77. Individual tubes showed differences top to bottom, ranging from 0.01 to 0.05 pH. Twenty-four hours after inoculation, all of the cultures were dead, pH top 3.78 to 3.80 and bottom 3.78 to 3.80. Only one tube showed a difference between top and bottom, and this amounted to only 0.01.

Ten tubes of Experiment 7 were inoculated at pH top 4.06 to 4.08 and bottom a steady 4.08. Twenty-four hours after inoculation all of the cultures were negative. There was no change in the pH of negative cultures.

Ten tubes of Experiment 9 were inoculated at pH top 7.48 to 7.51, bottom 7.35 to 7.40. On the 13th day after inoculation, three tubes were negative. These tubes had a pH of 6.18, 5.45, 5.56, with no difference between top and bottom of the respective tubes. The remaining cultures contained many trichomonads, but the organisms were sluggish with many rounded forms. Three of the positive cultures were measured at the same time and gave values of 5.28, 5.30, and 5.23 at both top and bottom of the respective tubes. Note that in this instance the pH of positive cultures is from 0.15 to 0.95 pH unit more acid than the negative tubes. Differences of this kind and magnitude have been seen very frequently in this laboratory. On the 15th day post-inoculation, one tube was negative with a pH of 5.25 top and 5.22 bottom. On the 16th day one negative tube was 5.08 top and bottom; the positive tube was pH 5.10 top and bottom. At the time of the first negative tube the pH of uninoculated tubes was 7.21 to 7.26 top and 7.19 to 7.22 bottom. The difference in individual tubes, top to bottom, ranged from 0.02 to 0.06 pH unit.

SUMMARY AND DISCUSSION

The data presented in this paper show clearly that there is a definite and shifting difference in the hydrogen ion concentration between various portions of the saline used as part of the medium. The magnitude and temporal relationships of these differences depend upon the manner in which the medium is prepared, the type of acid used to adjust the pH, and the portion of the pH scale which is used. Experiments not reported here have shown that the saline portion of the medium is very steady when adjusted to pH 3.42 with lactic acid. The large shift seen immediately after autoclaving in the egg medium is not observed in the absence of the egg. These facts seem to indicate that the egg portion of the medium has profound effects on the physiochemical structure of the medium complex and that these effects may be as important as the nutrients which the egg is supposed to furnish to the medium.

Trichomonas foetus will live in the medium herein described over a considerable range of constantly shifting pH values. In media of this type adjusted to certain pH ranges, it is not possible to distinguish accurately between the changes in pH due to the activity of the trichomonads and those changes due to the inherent instability of the medium. Cultures which have become negative show pH values of the order of 6.18 to 5.08. These variations occur in cultures which originally were as nearly identical as it is practical to obtain. At 4.08 to 4.28 the survival time of the trichomonads seems to be governed at least in part, by the type of acid used to adjust the medium. The figures show that either 0.20 pH unit is of vital importance in this range or that lactic acid is much more toxic than hydrochloric. In view of the results of Chalkley and Daniel (1934) on the effect of these acids on division in *Amoeba proteus,* the latter view is favored. Morgan and Whitehair, (1943) re-

port that the pH of positive trichomonad pyametra fluid varies from 6.6 to 8.6. This is in line with the reports of other investigators and covers the range of viability noted in these experiments. These facts, taken in connection with the observation on the effect of lactic and hydrochloric acids reported above, seem to indicate that it is not possible to evaluate accurately the effect of pH changes or a steady pH value on the physiology of *Trichomonas foetus,* unless the acid producing the hydrogen ion is known. In the paper cited above, Chalkley and Daniel have also shown that the effect of acids upon cell division depends not only on the type of acid used, but also, and of equal importance, upon the composition of the salt solution used as a test medium.

From the results reported in this paper and applicable data from other investigators, the writer suggests that because of its buffer action the usual egg slant-saline medium is not satisfactory for the investigation of possible relationships between trichomonads and hydrogen ion concentrations. There can be little doubt that the type of acid concerned is of considerable importance in producing the observed effects, and it is highly probable that the total titratable acidity and the nature of the acid are of greater significance than the simple concentration of the hydrogen ion.

References

Chalkley, H. W. and Daniel, George E. 1934 The effect of certain chemicals upon division of the cytoplasm in Amoeba proteus etc. Protoplasma **21**: 258–269.

Dole, Malcolm 1941 The Glass Electrode. John Wiley and Sons, New York.

Morgan, B. B. and Whitehair, C. Kenneth 1943 The pH of bovine trichomonad pyometra fluid. North Amer. Vet. **24**: 729–730.

Rees, Charles W. 1937 Obtaining bacteria-free cultures of *Trichomonas foetus* by means of microisolation. Am. J. Hyg. **26**: 283–291.

Schneider, Morris D. 1942 A new thermostable medium for the prolonged bacteria-free cultivation of *Trichomonas foetus.* J. Parasitol. **28**: 428–429.

THE MESOSTIGMATIC NASAL MITES OF BIRDS. I. TWO NEW GENERA FROM SHORE AND MARSH BIRDS*

R. W. Strandtmann

Preventive Medicine and Public Health Department, University of Texas Medical Branch, Galveston, Texas

Under this general heading it is my intention to present a series of studies on the Rhinonyssinae and eventually to organize them into natural groups and establish their relationships with other Mesostigmata.

My attention was first called to these interesting mites in 1947 when a survey was made for ornithosis among local shore birds (Pollard, 1947). Since the incidence of ornithosis proved to be fairly high in some of the birds tested we thought it would be interesting to test for the presence of the virus in blood-sucking parasites. True blood-sucking parasites, however, were rare; we found only occasional larvae of Trombiculidae (Wharton, 1947), a very few Hippoboscidae, and on one occasion larval ticks of a species of *Ornithodoros* on a brown pelican. But the incidence of nasal mites was quite high and an attempt was made to work with them. This brought us to a serious study of the group and to the realization that, (1) probably all species of birds have these parasites, (2) that only a very few species are as yet known, and (3) that the existing genera are ill-defined and often based on erroneous observations.

At present, genera are defined largely on the basis of dorsal plates, on the presence or absence of a peritreme, and on the position of the gnathasoma. I believe that the nasal mites are relatively recent descendants of well sclerotized, external parasites and that they are now in the process of losing the unneeded plates. This process is still in a very unstable condition and in my opinion the number or arrangement of dorsal plates is the least reliable of all the characters that may be used for generic concepts.

The function of the peritreme is not definitely known for any mites. Evidently though, it performs some function that is unnecessary in the environment provided by the inner passages of the bird's nose as the mesostigmatic nasal mites have only a very short peritreme or none at all. This character seems to have reached a more stable point than the shields and probably has true worth as a generic character.

The position of the gnathasoma appears to me to be a basic character and I would place the greatest emphasis on its position. The gnathasoma may be terminal so that it is entirely or almost entirely visible from above, or it may be ventral so that it is entirely or almost entirely hidden from above.

Vitzthum in 1935 reviewed the genera and species of mesostigmatic nasal mites and provided a key to the genera. Recently Cooreman (1946) described a new genus and species from the owl, *Asio otus,* and gave a French translation of Vitzthum's key, incorporating into it his new genus.

Received for publication, May 29, 1948.

* I wish to express my sincere appreciation to Dr. Richard Albert for his great assistance and enthusiastic perseverance in collecting host birds, to Roger Allen for his help in getting the mites from the birds, to Dorothy J. Eben who prepared most of the material, and to Olin E. Hunt who made Mr. Roy Latham's material available to me.

EXPLANATION OF PLATE I

Larinyssus orbicularis n. sp. Female

FIG. 1. Dorsal view.
FIG. 2. Dorsal view of palps and epistome.
FIG. 3. Chela.
FIG. 4. Ventral view of gnathasoma.
FIG. 5. Ventral view.

We have evidence that some of these genera are incorrectly defined and that other genera probably contain two or more distinctive types but our material is still too scant for a revision. We hope, however, to offer a key to genera in the near future.

Larinyssus n. g.
Type: *L. orbicularis* n. sp.

Gnathasoma mostly hidden from above. Stigma with a short peritreme and placed dorsally at about the level of coxae III and IV. The dorsum has a group of small shields which are rather difficult to distinguish. The dorsal body striations are mostly longitudinal. There is no hypostomal groove on the gnathasoma and consequently no hypostomal teeth. The lingula and epistome are rather well developed and not difficult to distinguish. There are only three pairs of ventral setae on the gnathasoma, the basal pair lacking. All legs have claws and pulvillus. Chelicerae well developed, the chelae are quite small but strongly denate and shear-like in both sexes.

The combination of a stigma with peritreme, ventral mouthparts, and numerous small dorsal plates distinguishes this genus from all others.

Larinyssus orbicularis n. sp.

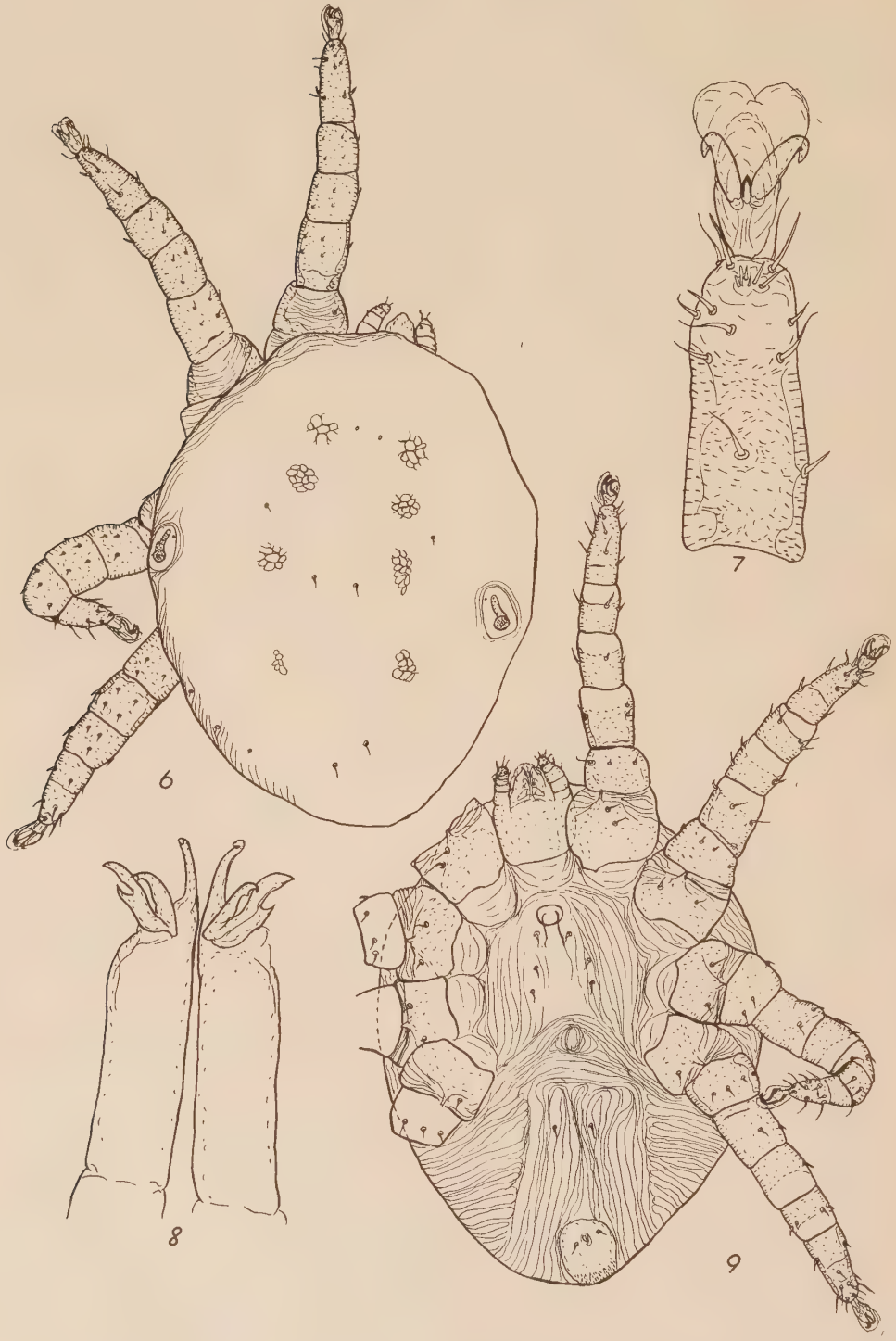
Female. Figs. 1–5. A rather large, pale brown, tick-like, orbicular mite. It averages approximately a millimeter in length although the measurements vary considerably as can be seen from the table of measurements given below.

All measurements are in microns

	Length	*Width*	*Leg I*	*Leg II*	*Leg III*	*Leg IV*	
Female	760	627	667	640	640	600	Royal Tern
"	813	680	667	...	...	...	" "
"	827	760	693	653	667	627	" "
"	893	693	667	628	627	620	" "
"	907	707	680	666	667	628	" "
"	920	733	667	641	653	613	" "
"	960	800	627	607	...	...	" "
"	840	680	667	627	653	...	Laughing Gull
"	1170	780	707	634	667	...	" "
"	1200	800	693	693	693	680	" "
"	1153	880	747	726	747	747	Ring-billed Gull
"	907	667					Herring Gull
"	907	667					" "
"	1000	680	780				" "
"	1000	693	720	693	693	693	" "
"	1200	867	713	680	680	693	" "
"	1200	...	753	...	...	...	" "
"	1280	840	760	733	707	707	" "
"	1333	...	733	713	707	747	" "
Male	827	653	600	533	...	560	Laughing Gull
Nymph	840	...	640	607	607	600	Ring-billed Gull
"	667	533	507	500	500	473	Herring Gull
"	800	...	466	493	480	453	" "
Larva	...	...	403	427	427	0	" "
"	667	533	403	...	429	0	" "

It would appear from these measurements that specimens from the gulls average larger than those from the tern but I can find no other morphological differences. The legs are all very nearly equal but legs I are consistently the longest.

The dorsum (Fig. 1) has fourteen very indistinct platelets and an additional extremely indistinct pair at the extreme posterior end. Scattered among the platelets are twelve pairs of points, some of which have definite setae. The others probably represent points that once had setae. The stigma and short peritreme lie in a small plate which has two small pores along the inner border. The stigma is dorsal and just above coxae III and IV. The body striations, except in the propodosomal area, are longitudinal. The venter (Fig. 5) has a fairly distinct but irregular anal plate. The anal pore is about its diameter from the anterior margin of the plate. The paired anal setae are opposite the anal pore and the odd seta is lacking. The genital plate is small and acute with a few fine lines. It lies entirely between coxae IV. There are no genital setae but there are three pairs of distinct setae between the anal and genital plates. There are three pairs of sternal setae with a nonstriated area between and above the first pair of these setae. This probably represents the last vestige of a vanished sternal plate. The ventral striations are quite oddly arranged and accurately depicted in Fig. 5, the most striking feature being the longitudinal striations in the central area above and beside the anal plate with the more

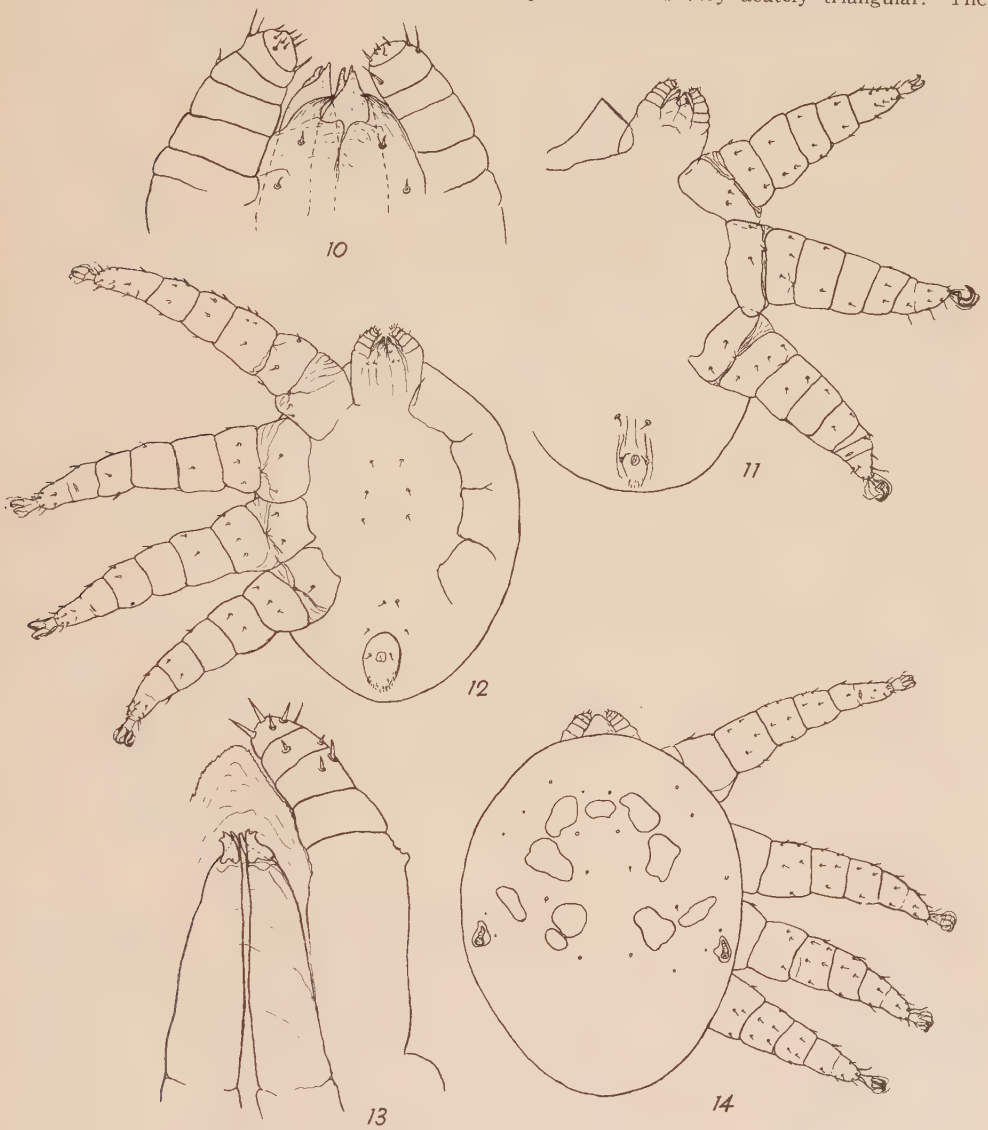


EXPLANATION OF PLATE II

Larinyssus orbicularis n. sp.

FIG. 6. Dorsal view of male.
FIG. 7. Dorsal view of tarsus I of female.
FIG. 8. Chelicerae of male.
FIG. 9. Ventral view of male.

lateral striations at right angles to these. The gnathasoma (Fig. 4) is short and stubby and ventrally placed. There is no hypostomal groove and there are only the three apical pairs of ventral setae. The palpal segments are much shortened and on the ventral side only the two apical segments have setae. The lingula is fairly distinct and very acutely triangular. The



EXPLANATION OF PLATE III
Larinyssus orbicularis n. sp.

FIG. 10. Ventral view of gnathasoma of larva.
FIG. 11. Ventral view of larva.
FIG. 12. Ventral view of nymph.
FIG. 13. Dorsal view of gnathasoma of nymph, showing chelicerae, epistome and palp.
FIG. 14. Dorsal view of nymph.

epistome (Fig. 2) ends anteriorly in a strongly convex line with a finely serrated margin. It reaches almost to the tips of the short palps. The chelicerae are well developed but the chelae, though well formed, are quite small. The chelae (Fig. 3) are shear-like with both arms pointed outward. The movable arm has a large tooth below the apex, the immovable arm is edentate.

Apparently there are no setae associated with either arm. The legs are stout and of uniform length. They seem to have the full complement of setae and the setae are well developed but not quite as distinct as the drawing indicates. The longest setae are at the apices of the tarsi. Fig. 7 shows a dorsal view of tarsus I of the female.

Male. Figs. 6–9. As generally seems to be the case in nasal mites, the males are rare and in the collection before me there is only one specimen of this sex. It is in rather poor shape and it is impossible to make out the details of the dorsum (Fig. 6). One can, however, see some of the setae and at least some of the platelets. Apparently it is not too different from the female. The venter (Fig. 9) is more distinct and is essentially like the female. The genital pore lies between the apices of coxae II. There are three pairs of sternal setae and no sternal plate. The striations form a circle between coxae IV, but this is not to be construed as a platelet. Apparently there is only one pair of setae between the anal plate and coxae IV, but this is very likely a variable character, at least it is so in the female and in other species of Rhinonyssinae. The chelae (Fig. 8) have both arms developed. The immovable is finger-like with a hooked apex. The movable has arising from its base a spermatophore-carrier somewhat larger than the immovable arm. This has a sharp process near the middle on the outer margin.

Larva. Figs. 10–11. The larva is colorless and non-sclerotized. It has no discernible plates and no stigma or peritreme. There is an indication of an anal plate. The paired anal setae are present and there is one pair of pre-anal setae. The ventral chaetotaxy of the leg is shown. The dorsal chaetotaxy of the leg is essentially like the nymph. I can discern no dorsal setae. The gnathasoma (Fig. 10) seems to have pointed and hooked but very poorly sclerotized corniculi. The chelae are very small. Apparently there are only two pairs of ventral setae. The lingula and epistome I cannot make out at all.

Nymph. Figs. 12–14. Four nymphs were available for study. They are colorless and poorly sclerotized. The dorsum (Fig. 14) has nine very indistinct plates and about nine pairs of spots, at least some of which bear setae. The venter (Fig. 12) has three pairs of sternal setae, two pairs of pre-anal setae and the paired anal setae. The gnathasoma is essentially as in the female. Fig. 13 shows the epistome and chelicerae. The chelicerae, except for being smaller are exactly as in the female. However, in the series of four nymphs before me only three have this type of chelae, the other has the larval type. This indicates that there are two nymphal stages although I can find no other structural differences.

Types. The above description is based on a collection of 36 mites; 29 females, 1 male, 4 nymphs, 2 larvae. Selected as holotype is a female specimen taken from the royal tern, March 25, 1947, Galveston, Texas. It and several paratypes including the male, a nymph and a larva are in the U. S. National Museum. Paratypes were collected during February and March of 1947 in Galveston and from the herring gull in Orient, Long Island, N. Y., December 19, 1947 by Roy Latham.

Hosts. *Sterna maxima* Boddaert, Royal Tern; *Larus argentatus* Pontoppidan, Herring Gull; *Larus delawarensis* Ord, Ring-billed Gull; *Larus atricilla* Linn., Laughing Gull.

DISCUSSION

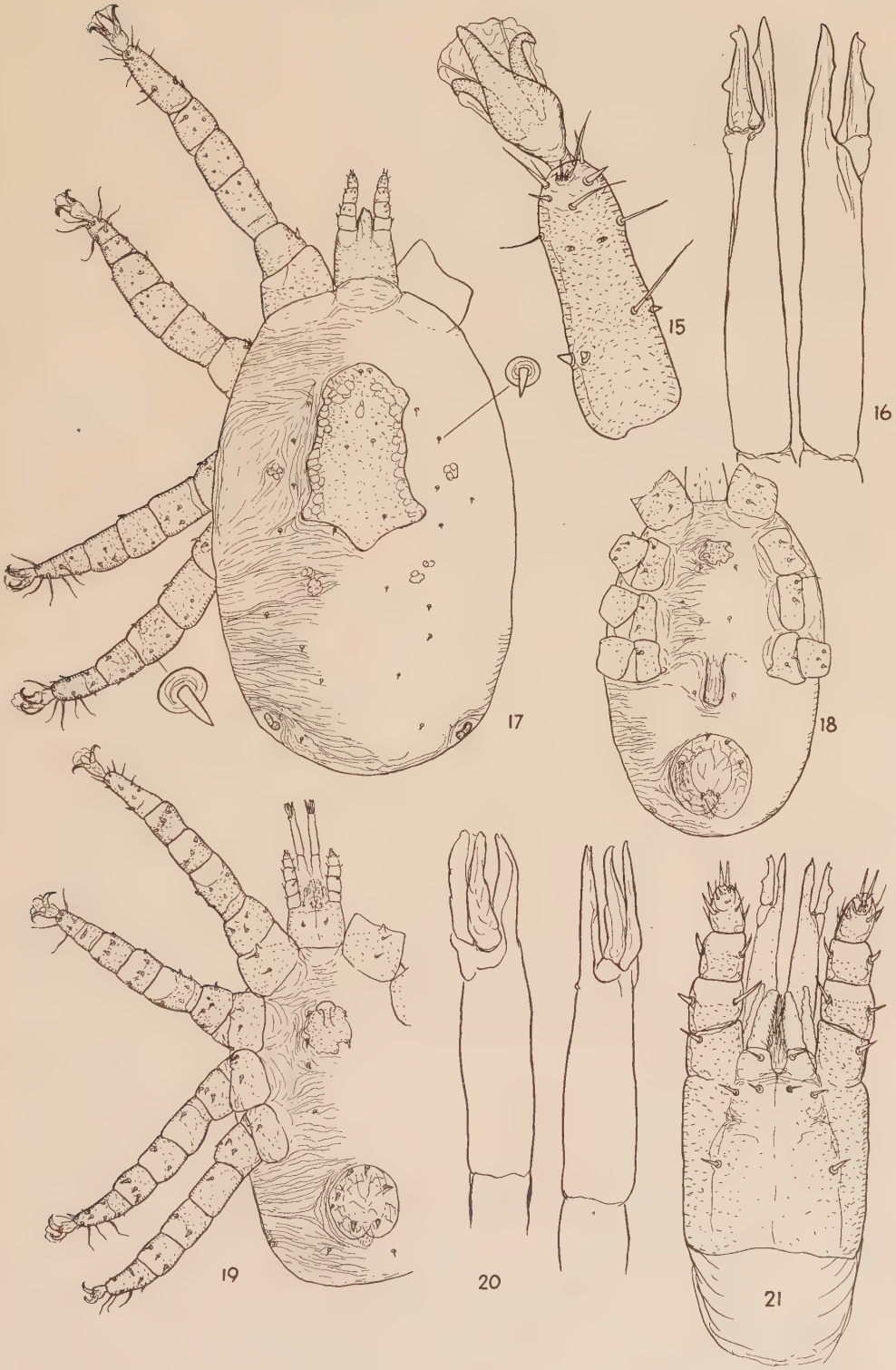
This mite is quite dark in color. Its orbicular shape, ventral mouth parts and deliberate movements remind one strongly of ornithodorid ticks. On two occasions I have seen the mite crawling over the body feathers of birds that have been kept over night in a refrigerator at approximately 50° F. It appears then that the mite is not completely dependent upon a constant warm climate and also that it will leave the nasal chambers when necessary. It seems obvious, of course, that it is essential for the spread of the species that the mite must upon occasion come out into the open.

Below is a list of the birds of the family LARIDAE that were examined by us in Galveston, giving the number parasitized by this mite.

EXPLANATION OF PLATE IV

Rallinyssus caudistigmus n. sp.

FIG. 15. Dorsal view of tarsus I, female.
FIG. 16. Chelicerae of female.
FIG. 17. Dorsal view of female.
FIG. 18. Ventral view of female.
FIG. 19. Ventral view of male.
FIG. 20. Chelicerae of male.
FIG. 21. Gnathasoma of female, ventral view.


15
16
17
18
19
20
21

	Total	Parasitized
Herring Gull (*Larus argentatus*)	9	1
Ring-billed Gull (*Larus delawarensis*)	4	1
Laughing Gull (*Larus atricilla*)	5	1
Bonaparte's Gull (*Larus philadelphia*)	3	0
Gull-billed Tern (*Gelochelidon niloteca*)	4	0
Forster's Tern (*Sterna forsteri*)	1	0
Royal Tern (*Sterna maxima*)	8	3
Least Tern (*Sterna antillarum*)	1	0

Ordinarily the number of mites per bird varies from 2–3 to 12 or 15, but 55 specimens were taken from the nose of the herring gull.

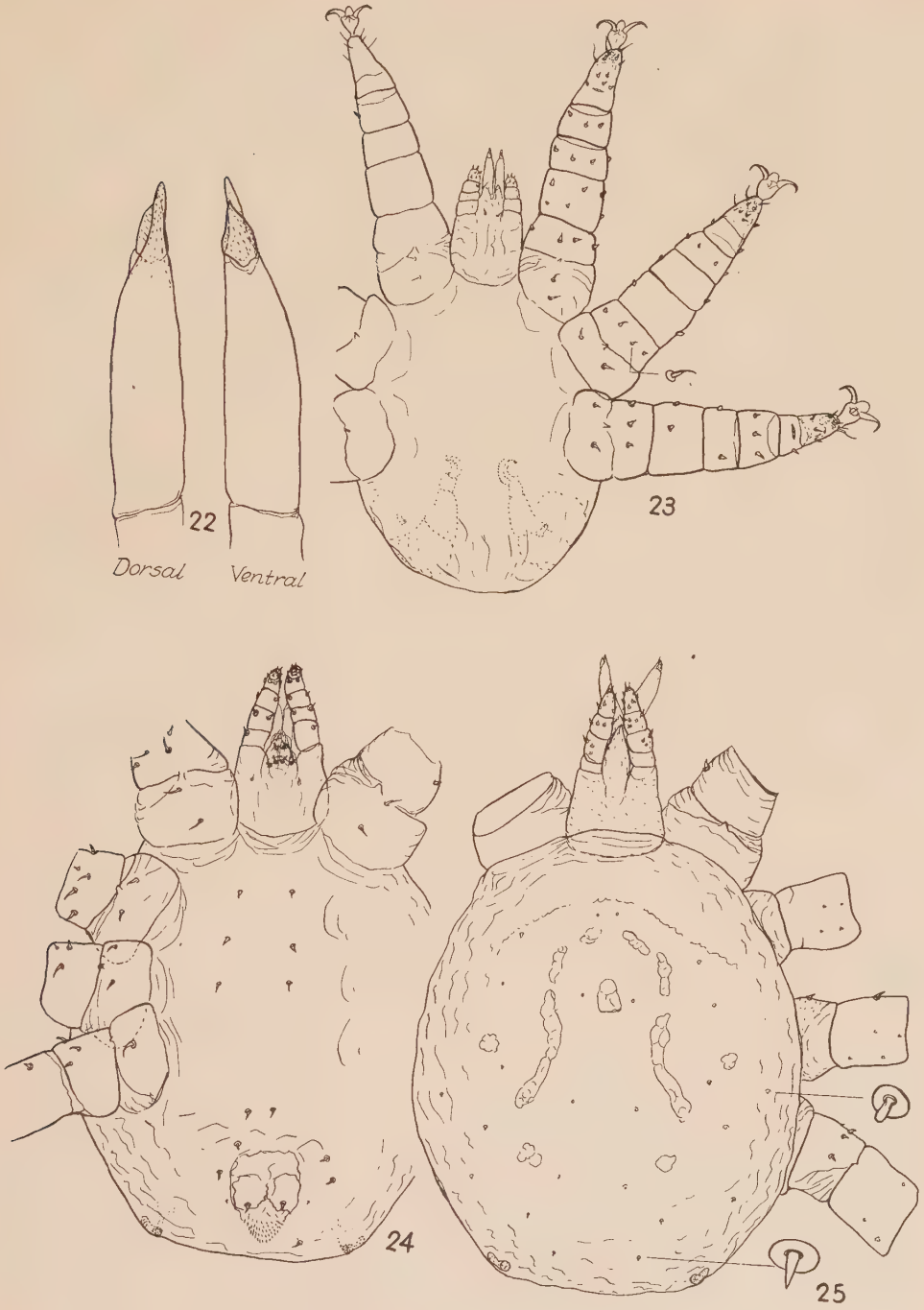
Rallinyssus n. g.
Type: *R. caudistigmus* n. sp.

Gnathasoma entirely visible from above. Stigma with a short peritreme and located dorsally at *the posterior end of the body*. The dorsum has in the adults a large podosomal shield and several smaller sclerotizations. Gnathasoma without a hypostomal groove but with four pairs of ventral setae as is normal for the family LAELAPTIDAE. Epistome ends anteriorly in a strongly arched line, with a few small teeth on the anterior margin. A definite cribrum lies below the anal pore, and in the adults there is anterior to the pore a free, cup-like membrane that appears to function as a vacuum cup. Chelae well developed and shear-like in both sexes. All legs with claws and pulvillus.

Distinguished from all other known genera by the posterior position of the stigma.

Rallinyssus caudistigmus n. sp.
Figs. 15–25

Female. Figs. 15–18, 21. A rather plump mite, elliptical in outline. It measures 1,320 μ long by 870 μ wide. The dorsal plate averages 480 μ in length by 320 μ in width. The dorsum (Fig. 17) has a large podosomal shield flanked by two lateral and two posterior small platelets. The large shield covers approximately a third of the podosoma and is roughly rectangular with a median posterior projection as shown in the figure but the outline varies considerably. There are twelve pairs of small setae scattered over the dorsum. The podosomal shield appears normally to contain two pairs of setae, but one or both of a third pair may be on the posterior portion of the shield. The striations on the non-sclerotized portion are mostly transverse. The venter (Fig. 18) has a small, very irregular sternal plate, a fairly well developed genital plate and a rather large disk-bearing anal plate. There is a pair of setae at the anterior corners of the sternal plate, one pair below the sternal plate and a third pair which may be found about midway between the sternal and genital plates although its position varies considerably. There is one pair of genital setae lying off the genital plate toward its posterior end. The anal disk appears to be a rather wide circular membrane attached to a large base just above the cribrum. Just where the anal pore is I cannot clearly determine, but it appears to be just above the cribrum. There are generally four stout setae under the free membrane but this number varies. A pair of stout setae is found at the anterior edge of the cribrum. The mouthparts (Fig. 21) are placed anteriorly. The hypostomal groove is lacking, but the full quota of four pairs of ventral setae are present and distinct, being rather short and all of approximately equal size. The epistome ends anteriorly in a strongly convex line with 2–4 weak teeth. It extends nearly to the apex of the second movable segment of the palp. The palps have a full quota of setae, with the ventral setae longer than the dorsal. The very small apical segment bears two long, straight setae and numerous smaller ones. The forked seta of the palp-tarsus is either lacking or extremely difficult to find as I have been unable to distinguish it. The chelicerae are well developed with strong, shear-like chelae. The two arms of the chelae are equal, with divergent apices. The movable arm has two blunt teeth on the outer edge, the immovable a single obtuse tooth on the *inner* edge. I can detect no setae at the base of either arm. The legs (Fig. 15) seem to have a full quota of setae but these are mostly small and indistinct. The ventral setae are longer and stouter than the dorsal with the exception of the tarsi. Here there are four to five long setae apically on the dorsal side. Coxa I has two slender setae, coxae II and III each have two slightly inflated setae, and coxa IV has one seta basally inflated. All trochanters have short basally inflated setae. Fig. 15 shows the dorsal side of tarsus I. The central claw-like pulvillus is not as distinct as the drawing indicates. The legs measured from the base of the coxa to the tip of the tarsus are as follows: I—870 μ, II—680 μ, III—700 μ, IV—790 μ.



EXPLANATION OF PLATE V

Rallinyssus caudistigmus n. sp.

FIG. 22. Chelicerae of nymph, dorsal and ventral views.
FIG. 23. Ventral view of larva.
FIG. 24. Ventral view of nymph.
FIG. 25. Dorsal view of nymph.

Male. Figs. 19 and 20. Only one male is present in this collection. It is 870 μ long. Leg I is 733 μ, leg II 600 μ, leg III 613 μ, and leg IV 667 μ long. The dorsal plate is 374 μ long. The dorsum is like that of the female. The venter shows an irregular sternal plate lying between coxae II. The genital pore is at the apex of this plate and four setae are on its margin. A third pair of setae is just below. A pair of very small setae are seen opposite coxae IV. Otherwise the male is like the female. The claw-lake pulvillus found on tarsus I of the female is lacking in the male. The chelae (Fig. 20) are shear-like but edentate and the movable arm bears a spermatophore carrier that is equal in size to the movable arm, giving it the appearance of a bifid chela.

Larva. Fig. 23. Two larvae were available for study. Both were ready to moult and the fourth pair of legs is visible, as well as the stigma and the claws within legs I–III. The larva is colorless and has no visible plates or body setae. The legs seem to have the same number of setae as do the adults. The claws are well developed but the pulvillus is quite small. There is no stigma or peritreme. Total length, 670 μ, leg I, 467 μ, leg III, 440 μ.

Nymph. Figs. 24–25. Only one nymph was available so it is not possible to know whether there is more than one nymphal stage. The measurements of this nymph are: length 760 μ, width 667 μ, leg I 720 μ, II 573 μ, III 560 μ, IV 627 μ. The dorsum has twelve pairs of setae and the four small platelets just as the adults. The central large shield is lacking but is represented by a broken, horseshoe shaped sclerotized line.

The venter has three pairs of sternal setae but lacks both the sternal and genital plates. There are four pairs of circumanal setae including a pair of very small ones opposite the anal pore. In addition, there is a pair of strong setae within the anal area and a pair of postanal setae, but this number probably varies as it does in the adult. The preanal cup-like disk is lacking. The gnathasome is similar to that of the adult, but the setae are shorter. The chelicerae (Fig. 22) are markedly different from those of the adult. The two arms of the chela are quite small and lack dentation. The movable arm is broadly triangular and much shorter than the narrow immovable arm. The chaetotaxy of the legs is similar to that of the adults. They are not so well sclerotized, however, and the claws are smaller and the pulvillus incompletely developed.

Types. This species is described from 7 females, 1 male, 1 nymph and 2 larvae. One female collected March 20, 1947, from the coot is designated the holotype and is deposited in the U. S. National Museum. All others have been designated as paratypes. The male, one nymph and one larva are also in the U. S. National Museum. The balance are in my collection.

Hosts. *Fulica americana* Gmelin, Coot; *Rallus elegans* Audubon, King Rail.

DISCUSSION

Since the RALLIDAE are migratory birds the locality in which the mites were collected is probably of no consequence, but for the record we will report that one female mite was collected by Roy Latham in Orient, Long Island, N. Y., May 11, 1947, from the king rail and all the other specimens were taken in Galveston, Texas, March 14 and 25, 1947 from the coot. We examined in Galveston a total of 24 coots (18 males, 6 females) and found only 2 (one male, one female) parasitized. Also examined and found negative were 3 clapper rails (*Rallus crepitans* Gmelin). Apparently the rate of parasitism is quite low.

The specimens were collected alive and stored temporarily in physiological saline at 50° F. After 24 hours they were still alive and active. They were quite sluggish and gave the impression that their movements were not too well coordinated. This was true before they were refrigerated so these reactions were not the result of low temperatures. The anal sucker-like modification could be seen to alternately flatten and cup up, as if feeling for something to which to attach. The stout setae under the rim of the sucker probably served to cup the membrane.

REFERENCES

VITZTHUM, H. GRAF. 1935 Milben aus der Nasenhöhle von Vögeln. J. f. Ornith. **83**: 563–587.

COOREMAN, JEAN 1946 *Rhinoecius oti* n. gen., n. sp. (Acarien, Rhinonyssinae). Bull. Mus. roy. d'Hist. Nat. Belgique. **22**: 1–4.

POLLARD, MORRIS 1947 Ornithosis in seashore birds. Proc. Soc. Exp. Biol. Med. **64**: 200–202.

WHARTON, G. W. 1947 Studies on North American Chiggers. 2. The Subfamilies and *Womersia strandtmani* n. g., n. sp. J. Parasit. **33**: 380–384.

IN MEMORIAM

RICHARD PEARSON STRONG, M.D., HON. SCI.D.

Richard Pearson Strong, born at Fortress Monroe, Virginia, March 18, 1872, died at Boston on July 4, 1948, following a long illness. With him passed away an outstanding world leader of Tropical Medicine. Fortunately for his country, he was at the height of his career when his specialized knowledge was sorely needed in a national emergency.

His merits and achievements as a teacher and a research worker in Tropical Medicine need not be extolled here, the following brief notes being confined to his activity in the field of Parasitology. While the average American physician regards Parasitology as a recondite subject, chiefly noteworthy for its bizarre terminology, to the medical practitioner in the tropics it is one of the cornerstones of his Art. No person was more fully aware of this truth than Dr. Strong. His interests extended even beyond purely Parasitological matters to all biological aspects of disease, as manifested by his own investigations and those he promoted among his associates.

In his early days in the Philippines, from 1899 to 1913, his activities were mainly centered in the Biological Laboratory, which he organized at the Bureau of Science in Manila. This period is marked by original work on amoebic dysentery and plague. The plague studies culminated in his field work on the pneumonic type of the disease in Manchuria in the winter of 1911. With his appointment as the first Professor of Tropical Medicine at Harvard Medical School (1913) opens the fecund era of Dr. Strong's several expeditions to South and Central America and to tropical Africa. It begins with a journey to Peru (1913), in association with E. E. Tyzzer, A. W. Sellards and C. T. Brues, for the study of bartonellosis. During the first World War his attention was focussed on louse-borne typhus in Serbia (1915) and on trench fever in France (1917). It was the writer's good fortune to be intimately associated with most of Dr. Strong's later medical explorations of the Amazon Basin of Brazil in connection with the Seventh Hamilton Rice Expedition (1924), West and Central Africa (1926–1927), Guatemala (1931 and 1932), the Belgian Congo (1934) and Peru (1937).

A variety of parasitological topics retained his attention on these journeys, but particularly human and animal trypanosomiasis, filariasis, onchocerciasis and various other aspects of helminthology, African tick fever, leishmaniasis and its possible connection with flagellate infections of plants, bartonellosis, etc. He was also extremely active in providing further opportunities for research and travel to his associates at the Department of Tropical Medicine of Harvard Medical School, which under his guidance became one of the foremost institutions of its kind.

During this strenuous period Dr. Strong proved himself a capable leader of men, adept at organizing the teamwork so essential for successful field investigations as well as at inducing the needed material support. Moreover, his energy and perseverance were able to cope with the many difficulties connected with publishing the scientific results of his explorations, as witnessed by a sizeable series of reports.

RICHARD PEARSON STRONG, 1872–1948.
Photograph taken April, 1946, at the presentation of the Legion of Merit.

After his retirement at Harvard in 1938, Dr. Strong devoted four arduous years to the task of rewriting E. R. Stitt's "Diagnosis, Prevention and Treatment of Tropical Diseases" (1st Edition, 1942; 2nd revised Edition, 1944). His awareness of the ever-increasing importance of Parasitology is apparent throughout this monumental treatise.

From its founding and for many years after Dr. Strong served on the Editorial Board of the Journal of Parasitology (1915–1939). He was one of the Charter Members of the American Society of Parasitologists (1925), who elected him President in 1927, in recognition of his outstanding work and life-long interest in the study of human and animal parasites.

Joseph C. Bequaert

BOOKS AND MONOGRAPHS RECEIVED

BENBROOK, E. A. (V.M.D., Professor and Head of Department of Veterinary Pathology, Iowa State College) and MARGARET W. SLOSS (B.S., D.V.M., Assistant Professor of Veterinary Pathology, Iowa State College). **Veterinary Clinical Parasitology.** 187 pp., 247 figs., 21 pp. bibliography, 11 pp. index. August, 1948. Iowa State College Press, Ames, Iowa. $4.50.

MARSHALL, JAMES (M.D., B.S., M.R.C.S., L.R.C.P. Consulting Dermatologist, Central Middlesex County Hospital; Director of Veneral Diseases Clinic, Royal Northern Hospital, London). **The Skin Diseases.** A MANUAL FOR PRACTITIONERS AND STUDENTS. XI + 363 pp., 214 text figs., and 8 colored plates. Copyright, 1948. MacMillan and Co., London. $7.50.

MORGAN, BANNER BILL (B.S., M.S., Ph.D., Associate Professor of Veterinary Science, College of Agriculture, University of Wisconsin) and PHILIP A. HAWKINS, (A.B., M.A., D.V.M., Associate Professor of Parasitology, School of Veterinary Medicine, Michigan State College). **Veterinary Protozoology.** 195 pp., 22 plates, 21 pp. bibliography. Copyright, 1948. Burgess Publishing Co., 426 South Sixth Street, Minneapolis 15, Minnesota. $4.00.

SMITH, DAVID T. (Professor of Bacteriology, Duke University School of Medicine) and DONALD S. MARTIN (Professor of Preventive Medicine and Public Health, Duke University School of Medicine), assisted by NORMAN F. CONANT, JOSEPH W. BEARD, GRANT TAYLOR, HENRY I. KOHN and MARY A. POSTON (all from Duke University School of Medicine). **Zinsser's Textbook of Bacteriology.** XI + 992 pp., 251 figs., 42 pp. index. Ninth Edition, Copyright, 1948. Appleton-Century-Crofts, Inc., New York. $10.00.

United States Public Health Service and Health and Safety Department, Tennessee Valley Authority. **Malaria Control on Impounded Water.** XIII + 422 pp., 215 figs. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

INDEX FOR VOLUME 34, NOS. 1-6

ABDEL-MALEK, ALBERT. Invasion route of *Nosema* sp. in the potato tuberworm, as determined by ligaturing 452
Acanthocephala, recognition as a phylum 1
ACKERT, JAMES E. (see Frick and Ackert) 192
Alosa sapidissima, shad, host of *Clinostomum* 493
AMEEL, D. J. (see Cort, Ameel and Van der Woude) 428
AMERICAN SOCIETY OF PARASITOLOGISTS:
Mailing dates of volume 33, Journal of Parasitology 72
Minutes of 37th Council Meeting 255
Minutes of 22nd Annual Business Meeting 259
Announcement of 23rd Annual Meeting 454
Amphilina (Cestodaria), new species from North America 479
Androlaelaps setosus (Acarina), description of male 134
ANGULO, JUAN J. A multilocular coenurus of *Multiceps* sp. in *Capromys pilorides* (Say, 1922) Desmarest, 1922 96
Ascaris lumbricoides in the muskrat 253
Ascariasis in dogs, treatment of 237
Ascaridia galli, duodenal mucus as a factor in age resistance to 192
BABERS, F. H. (see Knipling, Bushland, Babers, Culpepper and Raun) 55
BAKER, EDWARD W. *Myrmonyssus chapmani*, a new species of hypoaspid mite (Acarina: Laelaptidae) 386
Bakererpes (Cestoda), new species from nighthawk 93
BIJLMER, J. On the recovery of protozoa and eggs of some species of helminths in the human feces 101
Blackhead in turkeys, experimental studies on 137
Books and monographs received 518
BONNE, C. (see Faust and Bonne) 124
BRANCH, NINA (see Thurman, Branch and Mulrennan) 134
BRENNAN, JAMES M. New North American chiggers (Acarina, Trombiculidae) 465
BUSH, DONALD LEE. Experimental transmission of the "3M" strain of *Plasmodium cathemerium* to the duck and its chemotherapeutic suitability for routine anti-malarial screening 321
BUSHLAND, R. C. (see Knipling, Bushland, Babers, Culpepper and Raun) 55
CALERO M., CARLOS. Cutaneous myiasis in Panama 343
CAMIN, JOSEPH H. Mite transmission of a hemorrhagic septicemia in snakes 345
Capillaria, new species from spiny dogfish 163
Capromys pilorides (Rodentia), host of coenurus of *Multiceps* sp 96
CHANDLER, ASA C. A contribution to the study of certain avian strigeids (Trematoda) 207
Chiggers, a method for shipping 71
Chiggers, North American, new species of 465
CHIN, TA HSIUNG (see Tiner and Chin) 253
Clinostomum (Trematoda) in the shad) 493
COATNEY, G. ROBERT. The chemotherapy of malaria in relation to our knowledge of exoerythrocytic forms 275
Coccidia of the mink 486
COKER, COIT M. (see Hollis and Coker) 493
COLEMAN, NELL (see Haas, Wilcox, Laird, Ewing and Coleman) 306
Conidophrys pilisuctor (Protozoa), occurrence on *Corophium acherusicum* 253
COOPER, W. CLARK (see Coatney and Cooper) 275
CORT, W. W. Studies on the germinal development in rediae of the trematode order Fasciolatoidea Szidat, 1936 428
Cotylogaster occidentalis (Trematoda) life cycle and systematic position of 164
COULSTON, FREDERICK. The chemotherapy and immunology of pre-erythrocytic stages in avian malaria 290
COUSTON, FREDERICK (see Huff and Coulston) 264
Culex (Diptera), new species from Colombia 396
CULPEPPER, G. H. (see Knipling, Bushland, Babers, Culpepper and Raum) 55

Dactylogyrus (Trematoda), two new species of 111
Daniel, George E. Observations on the pH of a culture medium and on cultures of *Trichomonas foetus* 496
Dickerman, E. Eugene. On the life cycle and systematic position of the aspidogastrid trematode, *Cotylogaster occidentalis* Nickerson, 1902 164
Diphyllobothrium (Cestoda), infection in Florida 72
Ectoparasites, evaluation of insecticides against 55
Endolimax nana (Protozoa), effect of streptomycin on 142
Ewing, Frances M. (see Haas, Wilcox, Laird, Ewing and Coleman) 306
Farrell, Charles E. A successful method for shipping larval trombiculids (chiggers) .. 71
Fasciola hepatica (Trematoda), rabbits as hosts of 119
Fasciolatoidea (Trematoda), germinal development in rediae of 428
Faust, Ernest C. Mammalian blood flukes of Celebes 124
Fecal examination, methods of 101
Felsenfeld, Oscar (see Young and Felsenfeld) 229
Frick, Lyman P. Further studies on duodenal mucus as a factor in age resistance of chickens to parasitism 192
Garzoli, Ray F. (see Levine, Garzoli, Kuntz and Killough) 158
Gassner, F. X. The biology and control of the fox maggot, *Wohlfahrtia opaca* (Coq.) ... 44
Gerichter, Ch. B. Three new species of the genus *Metathelazia* (Nematoda) 75
Glaser, Rudolph W. Obituary note 165
Goodchild, Chauncey G. Additional observations on the bionomics and life history of *Gorgodera amplicava* Looss, 1899 (Trematoda: Gorgoderidae) 407
Gorgodera amplicava (Trematoda), bionomics and life history 407
Gursch, Otto F. Effects of digestion and refrigeration on the ability of *Trichinella spiralis* to infect rats 394
Haas, Victor H. Response of exoerythrocytic forms to alterations in the life-cycle of *Plasmodium gallinaceum* 306
Haemaphysalis (Acarina), new species from New Guinea 154
Hewitt, Redginal. The treatment of ascariasis in dogs with 1-diethyl-carbamyl-4-methyl-piperazine hydrochloride 237
Hitchcock, Dorothy J. The inhibition of bacteria by the metabolic products of trichomonads 114
Hood, Marion. *Diphyllobothrium* infection in Florida 72
Hollis, Edgar H. A trematode parasite of the genus *Clinostomum* new to the shad, *Alosa sapidissima* 493
Huff, Clay G. Symposium on exoerythrocytic forms of malarial parasites I. Introduction 261
Huff, Clay G. A search for pre-erythrocytic stages of *P. vivax* and *P. cynomolgi* 264
Huff, Clay G. (see Coulston and Huff) 290
James, Maurice T. (see Gassner and James) 44
Jameson, Jr., E. W. Myobiid mites (Acarina: Myobiinae) from shrews (Mammalia: Soricidae) of eastern North America 336
Jeffery, Geoffrey. Absence of *Trichinella spiralis* in rats in Puerto Rico 254
Killough, John H. (see Levine, Garzoli, Kuntz and Killough) 158
Knipling, E. F. Evaluation of selected insecticides and drugs as chemotherapeutic agents against external bloodsucking parasites 55
Kohls, Glen M. *Haemaphysalis ratti*, a new species of tick from rats in New Guinea and *Haemaphysalis krijgsmani*, new name for *Haemaphysalis novae-guineae* Krijgsman and Ponto, 1932, pre-occupied 154
Komp, W. H. W. (see Rozeboom and Komp) 396
Kuntz, Robert E. (see Levine, Garzoli, Kuntz and Killough) 158
Laird, Raymond L. (see Haas, Wilcox, Laird, Ewing and Coleman) 306
Lawrence, R. F. Studies on some parasitic mites from Canada and South Africa 364
Le Veque, J. A. (see Mohr and Le Veque) 253
Levine, Milton D. On the demonstration of hyaluronidase in cercariae of *Schistosoma mansoni* 158
Levine, Norman D. *Eimeria* and *Isospora* of the mink, (Mustela vison) 486
Li, L. (see Mao and Li) 380
Lincicome, David R. A note on the nematode genus *Pseudophysaloptera* 452
Lincicome, David R. Observations on *Neoechinorhynchus emydis* (Leidy), an acanthocephalan parasite of turtles 51

Litomosoides carinii (Nematoda), life cycle of 24
Malaria, avian, chemotherapy and immunology of pre-erythrocytic stages in 290
Malaria, chemotherapy in relation to exoerythrocytic forms 275
Malarial parasites, exoerythrocytic forms of 261
Malarial parasites, avian, tissue culture of exoerythrocytic schizogony 300
Mao, C. P. Snail hosts of *Schistosoma japonicum* in the Soochow-Wusih area, Kiangsu, China 380
McKay, Francis. Studies on experimental blackhead infection in turkeys 137
McMurry, Frank B. (see Self and McMurry) 21
Mediorhynchus (Acanthocephala), new species from bob-white 84
Metathelazia (Nematoda), three new species of 75
Mites, apparatus for removing from large quantities of materials 132
Mites, myobiid, from shrews 336
Mites, of birds, new genera and species 505
Mites, parasitic, from Canada and South Africa 364
Mohr, J. L. Occurrence of *Condiophrys pilisuctor* on *Corophium acherusicum* in Californian waters 253
Morehouse, Neal F. (see McKay and Morehouse) 137
Mulrennan, John A. (see Thurman, Branch and Mulrennan) 134
Multiceps sp. (Cestoda), coenurus of 96
Myiasis, cutaneous, in Panama 343
Myrmonyssus chapmani (Acarina), new species of mite 386
Nagaty, H. F. Trematodes of fishes from the Red Sea. Part 4. On some new and known forms with a single testis 355
Neoechinorhynchus emydis, (Acanthocephala) of turtles 51
New genera (indicated*) and new species (Volume 34, 1948):
Metathelazia multipapillata Gerichter 76
Metathelazia capsulata Gerichter 77
Metathelazia oesophagea Gerichter 77
Mediorhynchus colini Webster 84
Syphacia eutamii Tiner 87
Bakererpes addisi Webster 93
Prosthodendrium mizellei Seamster and Stevens 108
Dactylogyrus parvicirrus Seamster 111
Dactylogyrus aureus Seamster 112
Haemaphysalis ratti Kohl 154
Haemaphysalis krijgsmani Kohl 157
Capillaria hathawayi Read 163
Diplostomum crassum Chandler and Rausch 207
Uvulifer erraticus Chandler and Rausch 207
Neogogatea pandionis Chandler and Rausch 208
Rictularia dipodomis Tiner 332
Protomyobia brevisetosa Jameson 338
Amorphacarus hengererorum Jameson 340
Proctotrema malasi Nagaty 355
**Spiritestis arabii* Nagaty 359
**Hairana sohali* Nagaty 360
Hairana magnus Nagaty 361
Sternostoma tracheacolum Lawrence 366
Prolabidocarpus canadensis Lawrence 369
**Olabidocarpus* Lawrence 375
**Eulabidocarpus* Lawrence 375
**Prolabidocarpus* Lawrence 376
Myrmonyssus chapmani Baker and Strandtmann 388
Culex (Culex) scutatus Rozeboom and Komp 396
Culex (Isostomyia) bamborum Rozeboom and Komp 399
Culex (Melanoconion) batesi Rozeboom and Komp 403
Neoschöngastia fullbergae Brennan 465
Euschöngastia lacerta Brennan 468
Euschöngastia miricoxa Brennan 468
Euschöngastia cordiremus Brennan 470
Euschöngastia luteodema Brennan 470

Euschöngastia criceticola Brennan 473
Trombicula jamesoni Brennan 476
Amphilina bipunctata Riser 479
**Larinyssus* Strandtmann 507
Larinyssus obicularis Strandtmann 507
**Rallinyssus* Strandtmann 512
Rallinyssus caudistigmus Strandtmann 512
Nosema sp. (Protozoa), invasion route in potato tuberworm 452
Oliver-Gonzalez, Jose (see Jeffery and Oliver-Gonzalez) 254
Olsen, O. Wilford. Wild rabbits as reservoir hosts of the common liver fluke, *Fasciola hepatica*, in southern Texas 119
Oöchoristica ratti (Cestoda), life cycle of 243
Ophionyssus serpentium (Acarina), vector of hemorrhagic septicemia in snakes 345
Parasitism, duodenal mucus as a factor in age resistance to 192
Pfeiffer, A. V. Effect of streptomycin on *Endolimax nana in vitro* 142
Philip, Cornelius B. Tsutsugamushi disease (Scrub Typhus) in World War II 169
Philip, Cornelius B. Observations on experimental Q fever 457
Pinnipeds, hosts of pseudophyllidean cestodes 211
Plasmodium cathemerium, experimental transmission of "3M" strain to duck 321
Plasmodium cynomolgi, a search for pre-erythrocytic stages of 264
Plasmodium gallinaceum, response of exoerythrocytic forms to alterations in life-cycle 306
Plasmodium lophurae, resistance of egg-laying ducks to 389
Plasmodium vivax, a search for pre-erythrocytic stages of 264
Porocephalus crotali (Pentastomida) 21
Porter, Richard J. Studies in tissue culture of exoerythrocytic schizogony in avian malarial parasites 300
Pratt, Harry D. (see Weinstein and Pratt) 231
Prosthodendrium (Trematoda), new species of from bat 108
Protozoa, intestinal, in San Juan, Puerto Rico 229
Pseudophyllidean cestodes from Alaskan pinnipeds 211
Pseudophysaloptera (Nematoda) 452
Q fever, experimental 457
Raun, E. S. (see Knipling, Bushland, Babers, Culpepper and Raun) 55
Rausch, Robert (see Chandler and Rausch) 207
Read, Clark P. A new capillarid nematode from the spiny dogfish, *Squalus acanthius* ... 163
Read, Clark P. *Spirometra* from Texas cats 71
Rees, Charles W. (see Tobie and Rees) 162
Rendtorff, R. C. Investigations on the life cycle of *Oöchoristica ratti*, a cestode from rats and mice 243
Rictularia (Nematoda), new species from Kangaroo rat 332
Riser, Nathan W. *Amphilina bipunctata* n. sp., a North American cestodarian 479
Roque, Agustin L. (see Angulo and Roque) 96
Rozeboom, Lloyd E. Three new species of *Culex* (Diptera: Culicidae) from Colombia .. 396
Schistosoma japonicum in Celebes 124
Schistosoma japonicum, snail hosts of in China 380
Schistosoma mansoni, hyaluronidase in cercariae of 158
Schistosoma mansoni, hermaphrodites in a Puerto Rican strain of 240
Scott, J. Allen. An apparatus for removing tropical rat mites from large quantities of bedding material 132
Scrub typhus in World War II 169
Seamster, Aaron. A new species of *Prosthodendrium* (Trematoda: Lecithodendriidae) from the large brown bat 108
Seamster, Aaron. Two new Dactylogyridae (Trematoda: Monogenea) from the golden shiner 111
Self, J. Teague. *Porocephalus crotali* Humbolt (Pentastomida) in Oklahoma 21
Short, Robert B. Hermaphrodites in a Puerto Rican strain of *Schistosoma mansoni* ... 240
Spirometra (Cestoda) from Texas cats 71
Stabler, Robert M. Variations in virulence of *Trichomonas gallinae* in pigeons 147
Stabler, Robert M. Protection in pigeons against virulent *Trichomonas gallinae* acquired by infection with milder strains 150
Steinhaus, Edward A. (see Abdel-Malek and Steinhaus) 452
Stevens, Arthur L. (see Seamster and Stevens) 108

STRANDTMANN, R. W. (see Baker and Strandtmann) 386
STRANDTMANN, R. W. The mesostigmatic nasal mites of birds. I. Two new genera from shore and marsh birds 505
Strigeids, avian, new species 207
STRONG, RICHARD PEARSON, obituary notice 515
STUNKARD, HORACE W. Pseudophyllidean cestodes from Alaskan pinnipeds 211
SUBBAROW, Y. (see Hewitt, Wallace, White and Subbarow) 237
Syphacia eutamii (Nematoda), new species from least chipmunk 87
THURMAN, JR., D. C. Description of the male of *Androlaelaps setosus* Fox (Acarina: Laelaptidae) 134
TINER, JACK D. *Syphacia eutamii* n. sp. from the least chipmunk, *Eutamias minimus*, with a key to the genus (Nematoda; Oxyuridae) 87
TINER, JACK D. The occurrence of *Ascaris lumbricoides* L. 1758 in the muskrat, *Ondatra zibethica* L. 253
TINER, JACK D. *Rictularia dipodomis* n. sp. (Nematoda: Thelaziidae) from Kangaroo rat, *Dipodomys* sp. 332
TOBIE, ELEANOR JOHNSON. The cultivation of *Trypansoma cruzi* in dialysate medium ... 162
TRAGER, WILLIAM. The resistance of egg-laying ducks to infection by the malaria parasite, *Plasmodium lophurae* 389
Trematodes of fishes from Red Sea 355
Triatoma neotomae (Hemiptera), vector of *Trypanosoma cruzi* 231
Trichinella spiralis, absence in rats in Puerto Rico 254
Trichinella spiralis, digestion and refrigeration in rat infection 394
Trichomonads, inhibiton of bacteria by the metabolic products of 114
Trichomonas foetus (Protozoa), pH of cultures 496
Trichomonas gallinae, variations in virulence of strains 147
Trichomonas gallinae (Protozoa), protection in pigeons against 150
Trypanosoma cruzi (Protozoa), infection of *Triatoma neotomae* with 231
Trypanosoma cruzi, cultivation of 162
Tsutsugamushi disease in World War II 169
VAN CLEAVE, HARLEY J. Expanding horizons in the recognition of a phylum 1
VAN DER WOUDE, ANNE (see Cort, Ameel and Van der Woude) 428
WALLACE, WYETH (see Hewitt, Wallace, White and Subbarow) 237
WEBSTER, J. DAN. A new acanthocephalan from the bob-white 84
WEBSTER, J. DAN. Two cestodes from nighthawk 93
WEINSTEIN, PAUL P. The laboratory infection of *Triatoma neotomae* Neiva with *Trypanosoma cruzi* Chagas and subsequent transmission to white mice 231
WHARTON, G. W. (see Farrell and Wharton) 71
WHITE, ELIZABETH (see Hewitt, Wallace, White and Subbarow) 237
WILCOX, AIMEE (see Haas, Wilcox, Laird, Ewing and Coleman) 306
WILLIAMS, ROGER W. Studies on the life cycle of *Litomosoides carinii*, filariid parasite of cotton rat, *Sigmodon hispidus litoralis* 24
Wohlfahrtia opaca (Diptera), the biology and control of 44
YOUNG, VIOLA MAE. The occurrence of intestinal protozoa in adults in San Juan, Puerto Rico 229

INDEX FOR DECEMBER SUPPLEMENT, 1948
(No. 6, Section 2)

(*refers to page; other figures to abstract number)

Acanthocephala, cement glands in males 43
Ackert, J. E. Tissue phase of *Ascaridia galli* life cycle elucidated by artificial digestion apparatus 89
Aguirre Pequeno, Eduardo. The prognosis of Mel del Pinto (Pinto and Carate) 44
Allocreadium ictaluri (Trematoda), the life history of 105
Ameel, D. J. Germinal material in rediae of two species of trematodes from *Pomatiopsis lapidaria* 20
American Society of Parasitologists:
Program, 23rd annual meeting 1*
Author index 9*
Abstracts 11*
Officers for 1948 ..... 39*
List of former officers 39*
List of meeting places 41*
In Memoriam 42*
Members elected since November 1, 1947 ..... 43*
Amoebae, human intestinal, cultivation and antibiotic treatment 1
Amboebiasis, chemotherapy of 50
Amboebiasis, effect of black-tongue producing diet on 86
Amboebiasis, epidemic in Japan 97
Andrews, John S. Effect of worm parasites on the growth of and feed utilization by pigs 11
Andrya macrocephala (Cestoda), variations in 57
Apororhynchus sp. (Acanthocephala) from North American birds 58
Ascaridia galli (Nematoda), relation of gonadal hormones to 28
Ascaridia galli (Nematoda), tissue phase of life cycle 89
Ascarids, condemnation of swine carcasses due to icterus 14
Ascaris lumbricoides var. *suum*, humidity requirements of ova 47
Azar, Joseph E. An intensive treatment regimen of vesical schistosomiasis with fuadin .. 76
Bacigalupo, Juan. Virulent plasma in malaria by *Plasmodium gallinaceum* Brumpt, 1935 10
Bacigalupo, Juan. Vaginal sphincter, new organ of *Echinococcus granulosus* 66
Baernstein, Harry D. (see Rees, Reardon and Baernstein) 3
Bailey, John K. Studies on a haemogregarine from the leopard frog 60
Balamuth, William. Comparative studies on cultivation and antibiotic treatment of the human intestinal amoebae 1
Ball, Gordon H. A gregarine from the sand-crab, *Emerita analoga* 23
Bangham, Ralph V. Variation in distribution of Wisconsin fish parasites 48
Beaver, Paul C. Progress report on a study of methods of pinworm diagnosis 51
Berry, Elmer G. *Pomatiopsis lapidaria* (Say), an American intermediate host for *Schistosoma japonicum* 18
Blackhead in turkeys, prevention by quinoline compounds 27
Blood parasites of birds from California 107
Bonilla-Naar, Alfonso. AEX and "Faust Simplificado" (Bonilla-Naar), two new methods for investigating intestinal parasitism 91
Bradin, Jr., John L. Oxidation-reduction potentials of *Entamoeba histolytica* in an essentially synthetic medium 2
Brooke, M. M. P.V.A.-fixative as a preservative and adhesive solution for staining protozoa in dysenteric stool and other liquid materials 6
Byrd, Elon E. *Apororynchus* sp. (Apororhynchidae: Acanthocephala) from North American birds 58
Byrd, Elon E. (see Denton and Byrd) 63
Carpenter, Elizabeth H. (see Lincicome, Thiede and Carpenter) 68
Cestoda, speciation in 22
Chernin, Eli. The incidence of *Leucocytozoon simondi* Mathis and Leger, 1910 among domestic ducks in northern Michigan 25

Chiggers, distribution of 24
CIORDIA, HONORICO. The number and morphology of the chromosomes of a digenetic trematode, *Rhopalias macracanthos* Chandler, 1932, from the opossum 16
Color slides, simplified method of displaying 67
CORT, W. W. (see Ameel, Cort and Van der Woude) 20
CRAM, ELOISE B. (see Filles and Cram) 19
CUCKLER, ASHTON C. Chemotherapy of experimental amoebiasis in rats and mice 50
Culex quinquefasciatus (Diptera), transmission of Japanese encephalitis by 73
Cultivation medium, lipoidal extract 4
DAVIS, LEONARD R. A simplified method of displaying 2″×2″ color slides 67
DAVIS, C. D. (see Ritchie and Davis) 97
DENTON, J. FRED. Dicrocoeliid trematodes of North American birds 63
DENTON, J. FRED. (see Byrd and Denton) 58
Dicrocoeliid trematodes of North American birds 63
Diphyllobothrium stemmacephalum (Cestoda), notes on 21
Dirofilaria immitis, in dogs from Mississippi 101
Echinococcus granulosus, a new organ of 66
Eimeria tenella (Protozoa), infection in chickens with induced mild hyperthyrosis 82
Endamoeba histolytica, cultivation without bacteria 3
Endamoeba histolytica, changes of 7
Endamoeba histolytica, in man in Wisconsin 68
Endamoeba histolytica, variations of trophozoites of 74
Entamoeba histolytica, oxidation-reduction potentials of 2
FEIGELSON, PHILIP. (see Manwell and Feigelson) 9
FERGUSON, M. S. Culture experiments with *Heterodera marioni* 92
Filarial worms of the cotton rat, infection experiment with 45
Filarial worms of the cotton rat, anatomical structures of 46
FILES, VIRGINIA S. A study on the comparative susceptibility of snail vectors to strains of *Schistosoma mansoni* 19
Folliculinids, associated with *Limnora* 72
GARABEDIAN, G. A. (see Azar, Pipkin and Garabedian) 76
GINGRICH, WENDELL D. The prophylactic and suppressive antimalarial effect of metachloridine with *Plasmodium cathemerium* in the canary 103
GOBLE, FRANS C. Chemotherapy of experimental trypanosomiasis with certain bis (2-methyl-4-amino-6-quinolyl) amides and ethers 41
GOLDMAN, MORRIS. (see Brooke and Goldman) 6
GOMEZ-VARGAS, MIGUEL. (see Bonilla-Naar and Gomez-Vargas) 91
Gregarine from sand-crab 23
GUTHRIE, JAMES E. Phenyl mercuric compounds for the removal of tapeworms from poultry 17
HABERMAN, WARREN. The occurrence of *Hypoderma* larvae in the spinal cord of cattle (Diptera: Oestridae) 26
Haemogregarine from leopard frog, studies on 60
HANSEN, EDER L. (see Bradin and Hansen) 2
HANSEN, M. F. (see Todd and Hansen) 81
HANSEN, M. F. (see Todd and Hansen) 82
HARTMAN, ERNEST. Methylene blue precipitated with cadmium chloride as a restraining agent for blood and tissue protozoa 106
HARWOOD, PAUL D. (see Guthrie and Harwood) 17
HAWKINS, PHILIP A. *Moniezia expansa* infections in sheep 93
HENDRICKS, JAMES R. Comparing the immune response of young and old mice to infections with 50 and 300 larvae of *Trichinella spiralis* 88
HERMAN, CARLTON M. Blood parasites of birds from Kern County, California 107
Heterodera marioni (Nematoda), culture experiments with 92
HIRSHFIELD, HENRY I. The morphology of *Urceolaria karyolobia* sp. nov., *Trichodina tegula* sp. nov., and *Scyphidia ubiquita* sp. nov. from Southern California limpets and turbans 90
HIRSHFIELD, HENRY I. The protozoan fauna of some species of intertidal invertebrates in Southern California 108
Hookworm of cattle, phenothiazine as a larvacide against 13
HUNTER, III, G. W. Parasitological studies on the Far East. II. An epidemiological survey of Fukui Prefecture, Honshu, Japan 98

HUNTER, III, G. W. Parasitological studies in the Far East. IV. An epidemiological survey in Yamanashi Prefecture, Honshu, Japan 100
HUNTER, III, G. W. (see Ritchie, Hunter, Pan, Szewczak and Ishii) 99
HURLBUT, HERBERT S. The cyclic transmission of Japanese encephalitis by *Culex quinquefasciatus,* utilizing young albino mice 73
Hymenolepis (Cestoda), vitamins in alcoholic debilitation of mice infected with 87
Hypoderma (Diptera), larvae in spinal cord of cattle 26
ISHII, N. (see McMullen, Ishii and Mitoma) 95
ISHII, N. (see Hunter, Ritchie, Nagano, and Ishii) 98
ISHII, N. (see Ritchie, Hunter, Pan, Szewczak and Ishii) 99
ISHII, N. (see Hunter, Ritchie, Kaufman, Pan, Szewczak Yokogawa and Ishii) 100
JONES, ARTHUR W. Speciation in the Cestoda 22
JONES, D. J. (see Andrews and Jones) 11
KAUFMAN, E. H. (see Hunter, Ritchie, Kaufman, Pan, Szewczak, Yokogawa and Ishii) . 100
KRUIDENIER, FRANCIS J. Metachromatic determination of mucoprotein distribution in *Paragonimus kellicotti* 52
LARSH, JR., JOHN E. Th effect of a blacktongue producing diet on experimental amoebiasis in dogs 86
LARSH, JR., JOHN E. The role of certain vitamins in alcoholic debilitation of mice infected with *Hymenolepis* 87
Leptorhynchoides thecatus (Acanthocephala), distribution of 70
Leucocytozoon simondi (Sporozoa), incidence in ducks in Northern Michigan 25
LE VEQUE, J. A. (see Mohr and Le Veque) 72
LEVINE, NORMAN D. The destruction of horse strongyle larvae by chemicals 12
LINCICOME, DAVID R. Incidence of *Endamoeba histolytica* and other parasites of man in Wisconsin: I. Preliminary report on a group of college students 68
LINCICOME, DAVID R. Observations on the life cycle of *Neoechinorhynchus emydis,* an acanthocephalan parasite of turtles 69
LINCICOME, DAVID R. Distribution of *Leptorhynchoides thecatus,* a common acanthocephalan parasite in fishes 70
LUCKER, JOHN T. The effect of some nematode infections on the leucocyte count in sheep 29
MACDONALD, ETTA MAE. Infection experiments with the filarial worms of the cotton rat 45
MACDONALD, ETTA MAE. (see Scott and Macdonald) 46
Macracanthorhynchus hirudinaceus (Acanthocephala), chromosomes of 61
MALANGA, CHRISTINE. (see Cuckler and Malanga) 50
Mal del Pinto, prognosis of 44
MANWELL, REGINALD D. Glucose consumption of *Plasmodium gallinaceum in vitro* 9
MAYHEW, ROY L. Phenothiazine as a larvicide against the hookworm of cattle 13
MCCLURE, H. ELLIOTT. (see Herman, Reeves and McClure) 107
MCMULLEN, DONALD B. Seasonal studies on *Oncomelania nosophora* and the control of *Schistosoma japonicum* in Japan 94
MCMULLEN, DONALD B. Results of screening tests on chemicals as molluscicides 95
MCMULLEN, DONALD B. Seasonal studies of *Schistosoma japonicum* infections in the intermediate host, *Oncomelania nosophora* 96
MCQUAY, JR., RUSSELL M. Susceptibility of two species of Louisiana *Tropicorbis* to *Schistosoma mansoni* 62
MELENEY, HENRY E. (see Yolles, Moore and Meleney) 15
Mites, raising and handling 59
MITOMA, Y. (see McMullen, Ishii and Mitoma) 95
MOHR, J. L. Crystals in opalinids 53
MOHR, J. L. Folliculinids associated with *Limnoria* in California and Washington 72
Molluscicides, screening tests on 95
Moniezia expansa, infections in sheep 93
MOORE, DONALD V. (see Yolles, Moore and Meleney) 15
MOREHOUSE, NEAL F. Experiments on the use of quinoline compounds for the prevention of blackhead in turkeys 27
MORGAN, BANNER BILL. Chemotherapy of *Tritrichomonas foetus* infections in rabbits .. 8
MORGAN, BANNER BILL. (see Haberman and Morgan) 26
MORGAN, BANNER BILL. (see Rausch, Schiller, and Morgan) 55
MORGAN, BANNER BILL. (see Rausch, Morgan and Schiller) 56
MORGAN, BANNER BILL. (see Rausch, Schiller and Morgan) 57
NAGANO, K. (see Hunter, Ritchie, Nagano and Ishii) 98

NELSON, E. CLIFFORD. Lipoidal extract cultivation medium 4
Nematode infections, effect on leucocyte count in sheep 29
Nematodes, new concepts in embryology of 65
Nematode parasites of horses and mules 102
Neoaplectana glaseri, axenic cultures of 5
Neoechinorhynchus emydis (Acanthocephala), life cycle of 69
NEUMAYER, ELEANOR M. (see Lucker and Neumayer) 29
Ocular Disc, an improved ruling for 64
Oesophagostomum (Nematoda), experimental infection of pigs 71
OFFUTT, EDWARD P. An improved ruling for the ocular disc of special usefulness in parasitology 64
Oncomelania nosophora (Mollusca), seasonal studies on 94
Opalinids, crystals in 53
PAN, C. (see Ritchie, Hunter, Pan, Szewczak and Ishii) 99
PAN, C. (see Hunter, Ritchie, Kaufman, Pan, Szewczak, Yokogawa and Ishii) 100
Paragonimus kellicotti (Trematoda), mucoprotein distribution in 52
Parasites of blood, thedane blue methods of demonstration 54
Parasites of fish, variation in distribution of 48
Parasites of the Ranidae 78, 79, 80
Parasitism, intestinal, two new methods for investigating 91
Parasitological studies in Fukui Prefecture, Japan 98
Parasitological studies in Aomori Prefecture, Japan 99
Parasitological studies in Yamanashi Prefecture, Japan 100
Paranophlocephala (Cestoda), studies on species of 56
Paruterina (Cestoda), studies on 55
Peritrichous ciliates, three new species of 90
PIPKIN, ALAN C. The diagnosis of taeniasis by perianal swab 75
PIPKIN, ALAN C. (see Azar, Pipkin and Garabedian) 76
PIPKIN, ALAN C. Treatment of *Taeniasis saginata* with atabrine 77
Pinworm, diagnosis of 51
Plasmodium cathemerium, effect of metachloridine on 103
Plasmodium gallinaceum, glucose consumption *in vitro* 9
Plasmodium gallinaceum, virulent plasma in malaria by 10
Pomatiopsis lapidaria (Mollusca), an American intermediate host for *Schistosoma laponicum* 18
PORTER, DALE A. (see Davis and Porter) 67
Protozoa, methylene blue as a restaining agent for 106
Protozoan fauna of intertidal invertebrates in Southern California 108
P.V.A.-Fixative, a preservative and adhesive solution for staining protozoa 6
Ranidae (Amphibia), parasites of 78, 79, 80
RAUSCH, R. Studies on the cestode genus *Paruterina* (Cestoda: Dilepididae) 55
RAUSCH, R. Studies on species of *Paranoplocephala* parasitic in North American Rodents (Cestoda: Anoplocephalidae) 56
RAUSCH, R. Variations in *Andrya macrocephala* Douthitti 1915 (Cestoda: Anoplocephalidae) 57
REARDON, LUCY V. (see Rees, Reardon and Baernstein) 3
REEDER, ROBERT C. (see Ward and Reeder) 101
REES, CHAS. W. A biochemical approach to the problem of cultivating *Endamoeba histolytica* without bacteria 3
REEVES, WILLIAM C. (see Herman, Reeves and McClure) 107
Rhopalias macracanthos (Trematoda), chromosomes of 16
RITCHIE, L. S. Studies on epidemic amebiasis occurring in occupants of the Mantetsu apartment building, Tokyo, Japan. I. Parasitological findings and epidemiological aspects . 97
RITCHIE, L. S. Parasitological studies in the Far East. III. An epidemiological survey of Aomori Prefecture, Honshu, Japan 99
RITCHIE, L. S. (see Hunter, Ritchie, Kaufman, Pan, Szewczak, Yokogawa and Ishii) .. 100
RITCHIE, L. S. (see Hunter, Ritchie, Nagano and Ishii) 98
RIVERO, ENRIQUE. (see Bacigalupo and Rivero) 66
RIZK, EMILE. (see Pipkin and Rizk) 77
RUE, RUTH ELIZABETH. (see Berry and Rue) 18
SADUN, ELVIO H. Relation of the gonadal hormones to the natural resistance of chickens and to the growth of the nematode, *Ascaridia galli* 28

SADUN, ELVIO H. (see Chernin and Sadun) 25
Schistosoma japonicum, Pomatiopsis lapidaria, an American intermediate host for 18
Schistosoma japonicum, control of in Japan 94
Schistosoma japonicum, seasonal studies in intermediate host 96
Schistosoma mansoni, post-cercarial development of 15
Schistosoma mansoni, susceptibility of snail vectors to strains of 19
Schistosoma mansoni, susceptibility of *Tropicorbis* to 62
Schistosomatium douthitti (Trematoda), infective uniparental miracidia of 84
Schistosomes, inter-generic crosses among 83
Schistosomiasis, treatment with fuadin 76
SCHILLER, EVERETT L. (see Rausch, Schiller and Morgan) 55
SCHILLER, EVERETT L. (see Rausch, Morgan and Schiller) 56
SCHILLER, EVERETT L. (see Rausch, Schiller and Morgan) 57
SCOTT, J. ALLEN. Comparative studies on the anatomical structures of the third and fourth stage larvae of the filarial worms of the cotton rat 46
SCOTT, J. ALLEN. Apparatus and methods for raising and handling tropical rat mites 59
SCOTT, J. ALLEN. (see Macdonald and Scott) 45
SEAMSTER, AARON. Humidity requirements of *Ascaris lumbricoides* var. *suum* ova. 47
SEITNER, PHILIP G. Observations on the life history of *Allocreadium ictaluri* Pearse 105
SHORB, DOYS A. Experimental infections of pigs with *Oesophagostomum dentatum* and *O. longicaudum* 71
SHORT, ROBERT B. Inter-generic crosses among schistosomes (Trematoda: Schistosomatidae) 83
SHORT, ROBERT B. Infective uniparental miracidia of *Schistosomatium douthitti* (Trematoda: Schistosomatidae) 84
SIMONS, H. C. R. Ultra-rapid demonstration of unicellular blood parasites in minimum concentrations by thedane blue methods 54
SPINDLER, L. A. Ascarids a cause of loss to the meat industry through condemnation of swine carcasses due to icterus 14
STOLL, NORMAN R. Axenic cultures of *Neoaplectana glaseri* Steiner in fluid media 5
Strongyle larvae, horse, destruction by chemicals 12
Strongylid eggs, comparative fertility of 81
STUNKARD, HORACE W. Notes on *Diphyllobothrium stemmacephalum* Cobbold, 1858 21
SWARTZWELDER, J. C. Preliminary drug trials to determine anthelminthic activity against *Trichocephalus vulpis* in dogs 85
SZEWCZAK, J. T. (see Ritchie, Hunter, Pan, Szewczak and Ishii) 99
SZEWCZAK, J. T. (see Hunter, Ritchie, Kaufman, Pan, Szewczak, Yokogawa and Ishii) 100
Taeniasis, diagnosis by perianal swab 75
Taeniasis saginata, treatment with atabrine 77
Tapeworms of poultry, phenyl mercuric compounds for 17
THIEDE, WALTER H. (see Lincicome, Thiede and Carpenter) 68
THOMAS, JOHN I. (see Hurlbut and Thomas) 73
TOBIE, ELEANOR J. (see Von Brand and Tobie) 42
TODD, A. C. Comparative fertility of strongylid eggs passed by horses 81
TODD, A. C. *Eimeria tenella* infection in chickens with induced mild hyperthyrosis 82
Trematodes, germinal material in rediae of 20
Trichinella spiralis, immune response of young and old mice 88
Trichinosis, incidence in Alabama 104
Trichocephalus vulpis (Nematoda), drug trials against 85
Tritrichomonas foetus (Protozoa), chemotherapy of 8
Tropicorbis (Mollusca), susceptibility to *Schistosoma mansoni* 62
Trypanosomes, influence of SH-inhibitors on the oxygen consumption of 42
Trypanosomiasis, experimental, chemotherapy of 41
TSUCHIYA, H. Morphological variations of trophozoites of *Endamoeba histolytica* as affected by temperature and cultivation and its practical bearing on diagnosis 74
TUGWELL, R. L. (see Ackert and Tugwell) 89
VAN CLEAVE, HARLEY J. A detailed comparative study of cement glands in males of the Acanthocephala 43
VAN DER WOUDE, ANNE (see Ameel, Cort and Van der Woude) 20
VON BRAND, THEODOR. Influence of SH-inhibitors on the oxygen consumption of the blood stream form of some trypanosomes 42
WALKER, J. HENRY. The incidence of trichinosis in Alabama as indicated by the examination of the diaphragm and three other muscles from 300 autopsies 104

WALTON, A. C. Parasites of the Ranidae. XI, XII and XIII 78, 79, 80
WARD, HELEN L. The chromosomes of *Macracanthorhynchus hirudinaceus,* the giant thorny-headed worm 61
WARD, JAMES W. Incidence of *Dirofilaria immitis,* the dog heart worm, in dogs from Mississippi 101
WARD, JAMES W. Quantitative studies on nematode parasites of horses and mules 102
WHARTON, G. W. The distribution of pest chiggers near Duke University 24
WICKER, H. E. (see Swartzwelder and Wicker) 85
WOODHEAD, ARTHUR E. Some new concepts in the embryology of nematodes 65
Worm parasites, effect on pigs 11
YOKOGAWA, M. (see Hunter, Ritchie, Kaufman, Pan, Szewczak, Yokogawa and Ishii) 100
YOLLES, TAMARATH K. Post-cercarial development of *Schistosoma mansoni* in the rabbit and hamster after intraperitoneal and percutaneous infection 15
YOUNG, VIOLA MAE. Changes of *E. histolytica* 7